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A
CONCISE HISTORY
OF
ANCIENT INSTITUTIONS, INVENTIONS, AND DISCOVERIES
IN
SCIENCE AND MECHANIC ART;

Abridged and translated from the

Beyträge zur Geschichte der Erfindungen

OF

PROFESSOR BECKMANN,

Of the University of Gottingen:

WITH VARIOUS IMPORTANT ADDITIONS.

IN TWO VOLUMES.

VOL. II.

LONDON:
PRINTED FOR G. AND W. B. WHITTAKER,
AVE-MARIA-LANE.

1823.

LONDON
PRINTED BY COX AND BAYLIS, GREAT QUEEN STREET,
LINCOLN'S-INN FIELDS.

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BOOK III.

AUTOMATA.

VARIOUS KINDS OF AUTOMATA;—MARIONNETTES;—PHALLI;—ANCIENT STATUES AND MOVING FIGURES;—ANDROIDES;—AUTOMATIC DUCK;—FLUTE-PLAYER;—CHESS-PLAYER:—AUTOMATIC OPERA;—SPEAKING FIGURES;—ORACLES OF THE ANCIENTS;—OMBRES CHINOISES;—FANTOCCINI.

THE various kinds of puppets usually termed *Marionnettes*, the *Ombres Chinoises*, and the *Androides*, are ingenious mechanical contrivances, which are usually ranked under the indiscriminate title of *Automata*, although it properly belongs only to those machines

that are kept in motion by weights, springs, and wheels, and which are called Androides when they represent the human figure.

Of these, the *Marionnettes,* which are merely moved with strings, are the most ancient. They were common among the Greeks and Romans, and many of their authors speak of such figures,—termed by them *neurospasta,*—which they describe as moving their heads, eyes, and limbs, in a very natural manner. They were much used at their public shows; and among them may be ranked the *Phalli,* which were carried round the villages during the festivals of Bacchus and Osiris; as well as those other images, of a similar description, mentioned by Herodotus:—" *Festum Baccho Ægyptii celebrant, exceptis choris, fere per omnia eadem Græcis. Sed, loco phallorum, sunt ab eis excogitata aliæ statuæ circiter cubitales nervis mobiles, quas feminæ circumferunt per pagos, veretro nutante, quod non multo minus est cœtero corpore.*"

Whether the ancients were acquainted with any method of constructing *Automata,* or figures moved by springs, is a question not

easily resolved. We have, indeed, the testimony of both Plato and Aristotle, that Dædalus was said to have made statues which had not only a locomotive power, but which it was necessary to tie down in order to prevent them from running away! But the authority on which this assertion rested is exposed to more than doubt; and was, probably, little else than the exaggerated expression of admiration at statuary approaching nearly to the resemblance of life. The latter author, indeed, mentions a moving image of Venus, formed of wood; but he expressly says, that the motion was communicated to it by means of quicksilver, though in what manner that was effected he does not describe. The account given by Aulus Gellius of a pigeon that was constructed by Archytas of Tarentum, about four hundred years before the Christian æra, is equally imperfect; we are informed that it flew, but nothing is said from which any conclusion can be drawn respecting its mechanism. As to the head, upon the construction of which, in the thirteenth century, the monk Albertus Magnus is said to have bestowed the labour

of thirty years, all that is known respecting it is, that it is represented as having not only moved but spoken; and that Thomas Aquinas, terrified by its powers, and conceiving it to be formed by magic, broke it to pieces; which accident Albert bore with such philosophy, that he merely exclaimed, *periit opus triginta annorum!* At a still later period the well-known John Muller, or, as he is sometimes called, Regiomontanus,* made an iron fly, which is said to have flown about; and a wooden eagle, which flew to meet the Emperor Maximilian on his arrival at Nuremberg in 1470: but these pieces of mechanism are not mentioned by contemporary writers, nor are they described in the works of the supposed inventor.

The earliest, and certainly the most useful, invention that may be ranked amongst the Automata, of which we have any certain account, is that of clocks. When these were brought to perfection, some artists added figures to them, which performed various

* "*Regiomontanus.*" Also mentioned in Book I., Art. *Almanacks.*

evolutions at the time of striking; and when this attempt had succeeded, others endeavoured to construct those single human images which appear to move without assistance, and to which we apply the name of *Androides*. So early as the middle of the sixteenth century, a locksmith at Nuremberg constructed figures of this description, some of which beat a drum, and others played on the lute in proper musical time; and we know that, about the same period, the Emperor Charles V. amused himself in his retirement with similar pieces of machinery. It is also mentioned by the author of a poem entitled "*Zodiacus vitæ,*" that he saw at Rome, in the beginning of the sixteenth century, during the pontificate of Leo the Tenth, a figure, which had been constructed by a potter, that played upon a wind instrument; but no account is given of its construction, and it is merely described as follows:—

> "*Vidi ego dum Romæ decimo regnante Leone,*
> *Essem, opus à figulo factum, juvenisque figuram,*
> *Efflantem angusto validum ventum ores hiatu.*"

The first Androides that attracted atten-

tion in the last century, were those exhibited at Paris by the celebrated Vanconson, in 1738. They principally consisted of two figures; one representing a flute-player, which, as we are assured, played twelve tunes on a German flute, in the same manner as a living performer, while the other played on the shepherd's pipe, held in the left hand, and with the right beat upon the *tambour de basque.* There was also an automatic duck, of the natural size and plumage, which exhibited the usual movements of the animal, uttered the same sounds, ate and drank, and then voided its food in an apparently masticated state: the motion was communicated by means of a cylinder and slender chains, similar to those of a watch. But this figure cannot be considered as an original invention; for Labat tells us,* that the French General de Gennes, who in 1688 defended the island of St. Christopher against the English, had constructed a peacock, which performed similar movements. Of the flute-player,

* "*Labat.*" *Nouveau Voyage aux Isles de l'Amérique*, 4to. vol. ii.

there is a minute description in the Memoirs of the Royal Academy of Sciences at Paris, which is too curious to be omitted.

"The figure," we are told, "was about five feet and a half high, and was placed upon a square pedestal, which concealed a portion of the machinery. The air entered the body by three separate pipes, into which it was conveyed by nine pairs of bellows, which expanded and contracted in regular succession by means of a steel axis turned by clock-work. These bellows performed their functions without any noise, which might have discovered the means of conveying the air into the machine. The three tubes that received the air from the bellows passed into three small reservoirs in the trunk of the figure, where they united, and, ascending towards the throat, formed the cavity of the mouth, which terminated in two small lips. Within this cavity was a small moveable tongue, which, by its motion at proper intervals, admitted the air, or intercepted it in its passage to the flute. The fingers, lips, and tongue, derived their appropriate movements from a steel cylinder, also turned by clock-

works. It was divided into fifteen equal parts, which, by means of pegs pressing upon the ends of fifteen different levers, caused the other extremities to ascend. Seven of these levers directed the fingers, having wires and chains fixed to their ascending extremities, which, being attached to the fingers, caused them to ascend in proportion as the other extremity was pressed down by the motion of the cylinder, and *vice versâ*: then the ascent or descent of one end of a lever produced a similar ascent or descent in the corresponding fingers, by which one of the holes of the flute was occasionally opened or stopped, as it might have been by a living performer. Three of the levers served to regulate the ingress of the air, being so contrived as to open and shut the three reservoirs abovementioned, by means of valves, so that more or less strength might be given, and a higher or lower note produced. The lips were directed by four levers, one of which opened them to give the air a freer passage; the other contracted them; the third drew them backward; and the fourth pushed them forward: the lips were projected upon that

part of the flute which received the air, and by the different motions already mentioned, properly modified the tune. The remaining lever was employed in the direction of the tongue, which it easily moved, so as to open or shut the mouth of the flute. The just succession of the several motions performed by the various parts of the machine, was regulated by the following simple contrivance:—the extremity of the axis of the cylinder terminated on the right side by an endless screw, consisting of twelve threads, each placed at the distance of an eighth of an inch from the other. Above this screw was fixed a piece of copper, and in it a steel pivot, which, falling in between the threads of the screw, obliged the cylinder to follow those threads, and thus, instead of turning directly round, it was continually pushed on one side. Hence, if a lever was moved by a peg placed on the cylinder, in any one revolution, it could not be moved by the same peg in the succeeding revolution, because the peg would be an eighth of an inch beyond it by the lateral motion of the cylinder. Thus, by an artificial disposition of these pegs in

different parts of the cylinder, the statue was made by the successive elevation of the proper levers to exhibit all the different motions of a flute-player."

In the year 1752, one Du Moulin, a silversmith, travelled through Germany with similar Automata, which he sold at Nuremberg for three thousand florins, and afterwards went to Russia, where he constructed some curious machinery, and died at Moskow in 1765.

Some years after the exhibition of these Androides, the figure of a chess-player was shewn at Vienna, where it excited universal astonishment. It played with any bystander indifferently, made all the moves with the greatest accuracy, and displayed no small proficiency in the game; nor were there any visible means by which it might be directed, although it is certain that the mere power of machinery alone is insufficient to effect a movement that is not preconcerted. This machine was constructed at Presburgh by a gentleman named De Kempelen, who was director-general of the salt mines in Hungary. It represented a man of the natural

size, dressed as a Turk, and seated before the table which held the chess-board. The inside of both the table and the figure was filled with wheels, springs, and levers, which were shewn without hesitation, and entirely removed the suspicion which had been generally entertained, that a boy was concealed within.* It raised the arm, advanced it towards that part of the board on which the piece stood which ought to be moved, and then, by a turn of the wrist, it brought the hand down, closed it upon the piece, and placed it on the square to which it was to be removed; after which it laid its arm on a cushion placed on the table. When it had to take any of the adversary's pieces, it removed them at once from off the chess-board, and then, by a series of such movements as we have described, returned the hand to its own piece, and placed it on the square which the other

* A treatise was afterwards published, entitled "The Chess-player Detected," in which the same assertion was repeated; but it was not answered by M. de K., and did not obtain much credit.

had left vacant. The late Mr. Dutens, who played with this figure in the year 1771, in the presence of the English Ambassador and many other persons of distinction, relates that he attempted to deceive it, by giving the queen the move of a knight; but his opponent immediately detected the imposition, took up the queen, and replaced her in the position from which she had been removed. The figure appeared to look carefully over the board at every move, and gave notice of a check to the king by shaking its head. The only apparent communication which Mr. De Kempelen held with it, consisted in his occasionally winding up the springs in the arm; but this, it will be observed, although it might renew the *moving force*, could not convey any *power of direction*: it is, nevertheless, certain that the figure could not play unless the director was near it. An automaton of the same ingenious construction, and another that played on the piano-forte, both of which were recently exhibited in London, must be in the recollection of many of our readers.

A very ingenious piece of mechanism was

also invented by Monsieur Truchet, of the French Academy of Sciences: it was a moving picture, in the space of only sixteen inches and a half broad by thirteen high, which represented an opera of five acts, with a change of decoration in each, and consisted of a vast number of figures of a very diminutive size, which expressed by their gestures all the requisite action of a pantomime.

Speaking figures are supposed to be as ancient as the oracles of Egypt and of Greece. When the idolatrous statues at Alexandria were demolished, in the fourth century, some were found that were hollow, and so disposed against the walls, that a priest could stand behind unperceived and speak through the mouth. It was in this manner, no doubt, that the head of Orpheus, in the isle of Lesbos, appeared to speak, and that the oracles were delivered from the sacred grove around the Temple of Jupiter at Dodona. But the pagan priests were too cautious to trust entirely to such means of deception, and, therefore, sometimes deemed it less liable to suspicion to confide their answers to women who pretended to the gift of inspiration. The

oracle at Delphi, the most celebrated of antiquity, affords an instance of these means being jointly resorted to in the tripod and the Pythia. The same imposition was occasionally practised during the early ages of Christianity; but the images of the Saints have long been silent, and if ever their votaries heard a voice responsive to their prayers, the source from whence it came is no longer a mystery.

It is not known at what precise period these figures fell into the hands of lay jugglers; but we find that one of them excited great astonishment in this country in the reign of Charles the Second. It was exhibited by one Irson, an Englishman, and was visited by his Majesty and the whole Court, who were infinitely surprised at the pertinence of the answers it delivered to the various questions proposed, until a page discovered a person in an adjoining apartment, who was so placed as to hear what passed, and who replied through a pipe which communicated with the head of the image.

The *Ombres Chinoises* are, as the name indicates, a Chinese invention. They are

small figures, of pasteboard, the joints of which are pliable, and put in motion by lines communicating with pegs which are fastened to them. The space within which these puppets move, and which is usually made to represent the stage of a small theatre, is covered with a fine curtain of gauze, and is illuminated towards the apartment in which the spectators are placed, by means of light reflected back from a mirror, so that the shadows of the pegs and the action of the lines are concealed. In this manner the images perform without any apparent assistance, and while a dialogue is recited behind the scenes, they are made to represent the appropriate action. Considerable dexterity is requisite to manage them with effect, and more than one person must be employed for each puppet that is to perform a variety of movements; but when this is conducted with skill, the illusion is truly surprising. There was, not many years ago, a theatre in London entirely devoted to this amusement, under the title of the *fantoccini*.

BELLOWS.

ANCIENT USE OF BELLOWS;—ILLUSTRATIONS;—SMELTING WORKS;—DESCRIPTION AND ADVANTAGES OF WOODEN BELLOWS;—INVENTION.

The first instrument employed for blowing a fire was undoubtedly a hollow reed; but the art of imitating the action of the lungs, and supplying air by artificial means, was an early discovery, for our common bellows appear to have been known to the ancient Greeks. There is not, however, any passage in the authors of antiquity, from which information can be collected respecting the oldest construction of this machine; and this, however trivial the subject may appear, is to be regretted, as it would have contributed to enlarge the knowledge we possess of the metallurgy of the ancients.

In the following lines of the Georgics—

> —— "*Alii taurinis follibus auras*
> *Accipiunt, redduntque.*"*

we find a very plain allusion to bellows; and Virgil is not the only author who employs the expression "*folles taurinos,*" for Plautus also says, "*quam folles taurini habent, cum liquescunt petræ, ferrum ubi fit.*"†

Strabo tells us, on the authority of an old historian, that Anacharsis, the Scythian philosopher, invented the bellows, the anchor, and the potter's wheel; but this seems doubtful, as Pliny, Seneca, Diogenes Laertius, and Suidas, only attribute the two last to him; and Strabo also remarks, that the potter's wheel is mentioned by Homer, who lived prior to the time of Anacharsis. It is therefore probable that the latter became acquainted with it on his travels, and having made it known to his countrymen, was looked upon as the inventor.

Before the modern improvements in

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* Georg. lib. iv. l. 171.

† Plaut. in Fragmentis.

machinery, the bellows used in smelting-houses were worked by men; and this accounts for the remains of metallic substances being found in places destitute of water. The invention of the steam engine has, however, occasioned the restoration of some ancient works, which had been abandoned in consequence of the want of a stream of sufficient power to put the requisite apparatus in motion.

Bellows made with wood and leather are attended with many inconveniences, which are partly obviated by the use of wood alone. It is difficult to describe these bellows without the aid of an explanatory figure; but some idea may be formed of them from the following sketch.

The entire machine is composed of two boxes placed over each other, the uppermost of which can be moved up and down in the manner of a lid with a hinge; but the sides of the upper box are sufficiently large to contain the lower between them, when raised to its greatest extent. Both are fastened together at the smallest extremity, where the pipe is inserted, by a strong iron

bolt. It will be readily comprehended, that when the boxes fit each other with exactness, and the upper is raised over the under, which is immoveable, the space contained within both will be increased: consequently that more air will rush in through the valve in the bottom of the lower one; and that, when the upper box is again pressed down, this air will be expelled forcibly through the pipe. The only difficulty is to prevent any portion of the air from escaping at any other part of the machine than the orifice of the pipe; and this is obviated by the simple contrivance of placing moveable slips of wood on the inner sides of the uppermost box, which by means of metal springs are pressed to the sides of the lower box and fill up the intervening space.

The advantages of these bellows over those commonly used, consist in their greater duration, and in the effect produced by them being both stronger and more uniform. The invention belongs to Germany. So early as the middle of the sixteenth century, an artist, named Hans Lobsinger, gave to the Magistrates of Nuremberg a catalogue of

his machines, from the description of some of which it has been conjectured, that he was acquainted with the art of making such machines. But if that supposition be correct, it is also certain that the art died with him; and the earliest account to be relied on, ascribes the discovery to Martin and Nicholas Schelhorn, millers, who resided, about the year 1630, at the village of Schmalebuche, in the principality of Cobourg, in Franconia. Another account, indeed, assigns the invention to a Bishop of Bamberg; but it is unsupported by evidence; and a third, which is not devoid of probability, ascribes it to one Lewis Pfauneuschmidt, who, it is said, made such bellows for the smelting-houses in the forest of Harz, about the year 1621. In consequence of this the other bellows-makers conspired against him, and swore they would put him to death; but he was protected by the Government, and his family long enjoyed the monopoly of making bellows for all the works in the forest.

CANALS.

CANALS OF THE EGYPTIANS;—IMPERIAL CANAL OF CHINA;—CANAL BETWEEN THE DON AND THE VOLGA;—CANAL OF TROLHAETTA;—DUTCH, FRENCH, AND SPANISH CANALS;—ENGLISH CANALS;—NEW RIVER;—DUKE OF BRIDGEWATER'S CANAL;—REGENT'S CANAL;—LOCKS;—NEW INVENTION.

THE advantages of Canals are so obvious, that we find them in use among the most ancient nations of the world. The Egyptians connected the Mediterranean and Red Seas by a channel across the isthmus of Suez, while other canals united Alexandria, Canopus, and the most important cities of their country. The Roman emperors also attempted to divide the narrow neck that united the district of Peloponesus to the continent.

But the artificial navigations of the Egyptians, the Greeks, and the Romans, shrink

into apparent insignificance, when compared with the mighty works of the laborious and persevering Chinese. This extraordinary people conducted these almost interminable canals from the most remote quarters of their vast empire, until every town, nay, almost every village not immediately on the coast, had been visited in their turn. The imperial canal is one of the most magnificent monuments of human industry. Its extent, from Canton to the northern boundary of the empire, is nine hundred miles; the breadth fifty, and, the depth nine, feet; and consequently, it is navigable by vessels of considerable burthen, some of which use sails and oars, while others are towed. This immense canal passes forty-one cities, and a vast number of branches extend their minor ramifications to every river, every lake, and every navigable stream in their vicinity.

The canals have greatly contributed to produce and maintain the flourishing condition of China, and we learn from the concurrent testimony of historians and travellers, that the whole country may be traversed by water, except in the single instance of an

impervious mountain. Canals are, indeed, the highways of China.

Other parts of Asia, however, are not without the benefit of those aquatic communications; and we are informed by our illustrious countryman, Major Rennell, that Hindoostan enjoys these advantages in no inconsiderable degree.

But, quitting the remote empires of the Eastern world, let us turn our eyes towards Europe. Here we shall learn that the great Peter, of Russia, conceived and prosecuted the mighty projects of uniting Persia with the Baltic, and the Don with the Volga. These stupendous works were impeded by the death of the monarch; but such has been the energetic perseverance of his successors, that a communication by water, four thousand five hundred miles in extent, has been completed, from St. Petersburgh to Astracan, with the single intervention of an impassable line of sixty miles in extent.

In Sweden, too, the canal of Trolhäetta will, when completed, unite the Baltic with

the German Ocean; while Denmark has also been directing her active inquiries towards the same objects.

In Holland, a country as it were conquered from the dominion of the ocean, canals are numerous. Every province is intersected with navigable cuts, which, as in China, are used as roads. Nor do their communications terminate on the confines of the country, but, extending themselves into the contiguous parts of Germany, Flanders, and France, combine the double benefits of domestic and foreign commerce. The annual revenue of these canals has been estimated, by our ingenious countryman, Mr. Phillips, at the sum of £625 per mile.

Neither is France without canals; those of Burgundy, Orleans, the canal of Bourbon, and some others, are extensive; while that of Languedoc, forming a communication between the Mediterranean and the Atlantic Ocean, is celebrated among the grandest examples of human genius, and reflects equal honor upon the minister (Colbert) who pa-

tronized it, and on the engineer (Riquet) who conducted the works. The breadth is one hundred and forty-four feet, including the towing path; the depth six feet; the length sixty-four French leagues, and the highest part is six hundred feet above the level of the sea.

The canal of Arragon, in Spain, was commenced in 1781, but is yet incomplete. It is intended to facilitate the communication between the most flourishing parts of the kingdom; but the political state of the country precludes all hope of its immediate accomplishment.

Turning to our own country, we find the early vestiges of a Roman or Danish work, called Caerdyke, between the Nen, near Peterborough, and the Witham, near Lincoln. The extent is about forty miles, but it is now nearly filled with earth. This small cut is the only *ancient* artificial navigation of which any remains are extant; and it would seem, although in our time the English canals are quite unrivalled, yet that almost all the prodigious artificial navigations which have so vastly tended to aggrandize the British em-

pire, have been begun and finished in the limited period of fifty years.

The canal commonly called the New River, was projected about the year 1608, by Edward Wright, author of an excellent treatise on navigation, but was completed by Mr. (afterwards Sir Hugh) Middleton. The commencement is at Ware, in Hertfordshire, and the termination at what is called the New River Head, at Islington. Although the actual distance between Ware and Islington does not exceed twenty, this canal takes a circuitous route of sixty miles. In some places it is thirty feet deep, but its most remarkable feature is the circumstance of the whole being on one level. This canal is not used, nor was it ever intended, for navigable purposes, its only object being to supply the metropolis with water for domestic use.

After the completion of the New River, the disastrous circumstances which attended the pecuniary affairs of the proprietor deterred all future speculation of an analagous nature, until the late Duke of Bridgewater, about the middle of the last century, determined upon

the construction of a canal, on a line of peculiar difficulty, by means of which some rich coal mines, then useless from the peculiarities of their location, would be rendered directly accessible to the flourishing towns of Manchester and Liverpool. Having surmounted innumerable difficulties, through the able assistance of the celebrated engineer, Brindley, the Duke of Bridgewater's canal was at length completed, and the nation universally acknowledged that the scheme—which had been originally slighted and discouraged—was calculated to reward its noble projector, not alone with fame, but with the more substantial benefits of wealth.

After the successful completion of this canal, innumerable others were set on foot, and the number that have since that time been completed is so great, as to render it impossible, in a notice so limited as the present, to say more than that their total estimated length exceeds five thousand miles, and that the conveyance of merchandize by canals is now common to almost every part of the kingdom. The last work of this kind

the Regent's Canal, extending from Paddington to Limehouse, and passing through a tunnel three-quarters of a mile in extent, under the brow of Islington.

The construction of canals is necessarily dependant on a variety of local circumstances: the peculiarities of the ground—the proximity and level of rivers—the size of the boats intended to be navigated—and the supply of water. Of these, the last is often attended with circumstances of particular inconvenience. A great loss of water is experienced from the passage of vessels through the locks, which are necessary at every rise or fall of the canal. These locks consist of parallel walls of masonry, at a distance from each other sufficient to admit the vessels which navigate the canals. Between them, at each extremity, is a pair of gates, which meet each other in the centre, and open, or close the communication with either level of the canal, as occasion may require. Thus, if a vessel be supposed in the upper level of a canal, which it is desired to transfer to a lower level, the gates of the lock towards the

lower level must be closed; then, a sluice being opened in one, or both, of the gates contiguous to the upper level, the water rushes through the orifice, and the lock is presently filled. The vessel is now towed into the lock, and the upper gates being closed, a sluice in one, or both, of the lower gates is opened, and the water is discharged from the lock into the lower level of the canal. As the water subsides, the vessel, necessarily, descends with it, until the surface of the water in the lock is level with that of the lower level of the canal.

In transferring a vessel from a lower to a higher level, the operation is reversed; still, however, with the unavoidable loss of a quantity of water equal to the horizontal area of the lock, multiplied by the difference of the contiguous locks of the canal. In the locks of the Grand Junction and Regent's Canals, the quantity thus lost at every passage is about ten thousand cubic feet. To prevent this waste of water, a variety of ingenious mechanical contrivances, some of them of a very complicated nature, have been devised;

several of these have been tried, at an expense of many thousand pounds each, but every experiment has hitherto failed. We are, however, informed that Mr. Busby, a gentleman well known as an architect, has, at length, discovered a mode of operation, which, at a moderate expense, and without any mechanism whatever, may be applied to save, at least, four-sixths of the water now lost in lockage, and without any delay in the time of passing. We forbear to dilate on the particulars of this important discovery, as we learn that it will shortly become the subject of an application for a patent.

But we must not be understood as asserting that the waste by lockage is always the most important loss experienced by canals, because the losses from evaporation, soakage into the banks, and leakage at the lock-gates, must also be added. The loss from evaporation and soakage must uniformly depend upon the extent of surface, while those from lockage and leakage will be regulated by the quantum of traffic, and the number of falls in the canal. It consequently happens, in

cuts of short extent, and carrying on a great trade, that the lockage water is, by far, the most important of its losses; while, on the other hand, in canals of great length and less extensive use, the inconveniences produced by evaporation and soakage greatly exceed all others taken collectively.

CLOCKS AND WATCHES.

WATER-CLOCKS;—HOUR GLASSES;—INVENTION OF MODERN CLOCKS;—ANCIENT CLOCKS, IN ENGLAND, AND IN FOREIGN COUNTRIES;—PENDULUM CLOCKS;—WATCHES;—ARCHBISHOP PARKER'S STAFF;—REPEATERS;—WATCH OF KING ROBERT BRUCE;—KITCHEN JACKS.

THE ancients were wholly ignorant of the art of constructing mechanical clocks. It was not, indeed, until late in the fifth century of the Roman æra that the first sun-dial was introduced into Rome; and although that was calculated for another meridian, and was, consequently, incorrect in its new situation, it, nevertheless, continued, for ninety-nine years, to be the only instrument by which time was regulated in that celebrated city. At a later period a machine was invented, at Alexandria, termed a *clep-*

sydra, or water-clock. This was, in fact, nothing more than a basin filled with water, which was emptied in a certain number of hours, through a hole in the bottom, into another vessel, in which it rose around a graduated scale of the hours: or, more simply still, a conical glass with the scale marked on the sides; and which, being perforated at the base, denoted the hour as the liquid subsided. But these, unartificial as they were, served the purpose of ascertaining the time with tolerable accuracy; and to them may be traced the origin of that still common instrument the hour-glass. Various improvements were occasionally made in them, of the ingenuity of which we may form some idea from the description that has been given of one sent as a present to Charlemagne, in 807, by the Caliph Haroun Alraschid, which is said to have contained the figures of twelve knights, who, guarding as many doors, opened and shut them according as the hours revolved, and struck the time upon a metal bell. This, indeed, has been considered as the origin of our modern clocks; but the manner in which it is mentioned in the *An-*

nales Francorum, clearly shows that it was merely a water-clock of uncommon construction. There is also a very ingenious modern machine, known under the name of a water-clock. It consists of a cylinder divided into small cells, and suspended by a thread fixed to the axis in a frame on which the hours are marked. As the water flows from one cell into another, it slowly changes the centre of gravity of the cylinder, and puts it into motion. It is supposed to have been invented in Italy, about the middle of the seventeenth century.

Both the period of the discovery and the name of the inventor of clocks moved by machinery, are uncertain. It has been ascribed to various persons, in Europe, even so early as the ninth century; but, after a minute investigation of their several claims, there seems little doubt that the instruments of which they were the contrivers, were nothing more than some improvement, such as that already mentioned, on the water-clock, and that the origin of the present invention is not older than the eleventh century. About that time, clocks moved by weights and

wheels certainly began to be used in the monasteries of Europe. But still, it seems probable that we are indebted for them to the Saracens, from whom, indeed, in the early ages, all mathematical science appears to have emanated. They were at that period, no doubt, rude in their construction; and the numerous directions found in the ancient records of convents, for their regulation when out of order, would lead us to conclude that they must have been very imperfect in their operation. They pointed out the hour, indeed, by an index; and it also seems that they emitted a sound; but it does not clearly appear whether the latter is to be considered as a regular annunciation of the hours in progressive order, or only an occasional notice to the monks for the performance of their duties, according as the clock might be regulated, or struck, by the sacristan. The writers of the thirteenth century speak of them as being then well known; and they had become so common in the time of Chaucer, who died in 1400, that he alludes to them as a poetical simile for the crowing of a cock:—

> "Full sikerer was his crowing in his loge,
> As is a clock, or an Abbey orloge."*

The oldest clock of which there is any account, in this country, was erected in the year 1288, on a building called the clock-house, at Westminster. It was intended for the use of the courts of law, and it is a singular fact, that the expense was defrayed out of a fine imposed upon the chief justice of the King's Bench for altering a record of the court. It was considered of such value, that, in the reign of Henry VI., the care of it was entrusted to the Dean of St. Stephen's, with a salary of sixpence per day; and it was still existing in the time of Queen Elizabeth. The clock-house was standing so late as 1715, when it was pulled down to make room for the buildings in Palace-yard; and a memorial is still preserved on its site, of the former existence of the clock, in a dial, inserted in the second pediment of one of the houses

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* The word *orloge*, or *orologe*, was long used in this country synonimously with clock: and even at this day, the clock of the cathedral at Wells is called the *horologe*.

opposite Westminster-hall, and on which is this remarkable motto: "*discite justitiam moniti;*" which appears clearly to relate to the circumstances of its erection. For the credit of the judge—Radulphus de Hengham—it must not, however, be omitted, that the alteration made by him in the record of his court was solely with a view to mitigate a penalty imposed on a poor defendant.

Mention is also made of a great clock for the cathedral of Canterbury, which was erected in the year 1292 at an expense of thirty pounds. The most ancient clock now existing in England is that of Hampton-court palace, the date of which is 1540.

Leland gives an account of an astronomical clock, also made in England, in the reign of Richard II., by Richard de Wallingford, who, from being the son of a smith, raised himself, by his learning and ingenuity, to the dignity of Abbot of St. Albans. It not only told the hours, but the position of the sun and the fixed stars, the course of the moon, and the rise and fall of the tide; and it appears that it continued to go in Leland's time, who was born in the latter part of the reign of Henry

VII.: it was called by the inventor by the quaint name of Albion, sc. *All-by-one*.*

Clocks were, however, for a long time confined to monasteries; and it is remarkable, that the records of their general use, on the continent, are by no means of so early a date as that of those we have already described as publicly known in this country. The poet Dante, indeed, who was born in 1265, mentions them in the Paradiso; and his allusion is, plainly, to a clock which struck the hour:—

> " Indi come *horologio che ne chiami*,
> Nel hora che la sposa d' Idio surge,
> Amattinar lo sposo, perche l' ami."—*c. x.*

But the first public clock known to have been put up in Italy, was erected on a tower of the palace at Padua, early in the fourteenth century; that of Bologna was not fixed until 1356, nor that of Venice until 1497.

* This Richard de Wallingford was the author of a large folio on astronomy, the original M S. of which is still preserved, to which he also gave the name of Albion; it is remarkable for being the oldest English manuscript in which Arabic figures are used instead of the Roman numerals: the date is 1326.

In Spain, the first clock of which we have any account was made for the cathedral of Seville, in 1400. In France, we read in Froissart's Chronicles, that in the year 1332, the Duke of Burgundy removed from Courtray to his capital at Dijon, a famous clock, which struck the hours; and which was so large, that it was carried on cars. The first great clock at Paris was erected on the palace in 1372. It was made by a German; and we may conclude from that fact, and from the circumstance of a protection being on record as granted, in the reign of Edward III., to three Dutchmen, to exercise the art of clock-making in England, that it flourished at an early period in Germany: there is not, however, any certain account of a public clock having been erected in that country before the year 1395, when one was put up at Spire, the works of which cost fifty-one florins.

The invention of *pendulum clocks* is due to the ingenuity of the seventeenth century; and the honor of the discovery is disputed between Galileo and Huygens. Becher contends, in his work *de nova temporis dimetendi*

theoria, published in 1680, for Galileo; and relates, though at second-hand, the whole history of the invention; adding, that one Trefler, clockmaker to the father of the then Grand Duke of Tuscany, made the first pendulum clock, at Florence, under the direction of Galileo Galilei, and that a model of it was sent to Holland. The Academy del Cimento also expressly declared, that the application of the pendulum to the movement of a clock was first proposed by Galileo, and put in practice by his son Vincenzo Galileo in 1649. But, whoever may have been the inventor, it is certain that the discovery never flourished till it came into the hands of Huygens, who insists, that, if ever Galileo had entertained such an idea, he never brought it to perfection. The first pendulum clock made in England was constructed in the year 1662, by one Tromantil, a Dutchman.

Towards the close of the fifteenth century, clocks began to be used in private houses; and about the same time mention is first made of watches. It appears that they were originally formed in the shape of an egg, or at least of an oval, and that catgut supplied

the place of a metal chain, whilst they were commonly of a smaller size than those used until of late years. Of the latter, proof is afforded by the will of Archbishop Parker, dated in April 1575, in which he bequeaths to the Bishop of Ely, his staff of Indian cane *with a watch in the top*. That some of them were repeaters, is also proved by the fact, that Charles XI. of France, having lost his watch in a crowd, the thief was detected by its striking; yet the art of making these must have been afterwards lost, for we find it mentioned as an improvement in the reign of Charles II., and a patent was obtained for it in that of James II.

The oldest watch known in this country is that which was lately in Sir Ashton Lever's Museum: the date is 1541; but another is mentioned, in Derham's Artificial Clockmaker, published in 1714, which was said to have belonged to King Henry VIII., and was, therefore, probably earlier: it is a singular fact, that it was still in order when Derham wrote. Instances might be multiplied, to show that watches were known at the early period we have mentioned; but they do not

appear to have been in general use until about the time of Queen Elizabeth.

The chief part of this summary has been extracted from a memoir of the Honourable Daines Barrington, which excited considerable interest; and we cannot dismiss the subject without giving, in his own words, the account of a watch which, from the celebrity it acquired, at last found its way into the possession of his late Majesty.

"I shall now adduce proof that not only clocks but watches were made in the beginning of the fourteenth century. Seven or eight years ago, some labourers were employed at Bruce Castle, in Fifeshire, where they found a watch, together with some coins, which they disposed of to a shopkeeper in St. Andrew's, who sent the watch to his brother in London, as a curious piece of antiquity. The outer case is of silver, in rather a handsome pattern, upon a ground of blue enamel; and I think I can distinguish a cipher of R. B. at each corner of the enchased work. On the dial-plate is written, *Robertus B. Rex Scotorum*, and over it is a convex transparent horn, instead of the

glasses which we use at present. Now *Robertus* B. Rex Scotorum, can be no other king of Scotland than *Robert Bruce*, who began his reign in 1305, and died in 1328; for the Christian name of Baliol, who succeeded him, was Edward: nor can *Robertus B.* be applied to any later Scottish king. This very singular watch is not larger than those which are now in common use; at which I was much surprised, until I had seen several of the sixteenth century in the collections of Sir Ashton Lever and Mr. Ingham Forster, which were considerably smaller."

It may be imagined what a sensation the discovery of this curious relic created in the antiquarian world; what conjectures it gave rise to, and what doubts it terminated respecting the state of the arts in the fourteenth century. But alas! for the antiquaries; within a few years after its authenticity had been established by Mr. Barrington, there appeared, in the Gentleman's Magazine, a letter addressed to the editor, signed John Jameison, and dated Forfar, 20th August 1785, to the following effect:—

"You will remember that I formerly men-

tioned something to you in reference to the observations made by the Honorable Daines Barrington, on the earliest introduction of clocks—published in the Annual Register for 1779, under the article Antiquities. According to your desire, I will communicate what circumstances come within my personal knowledge, about a watch that corresponds very much to one described by him as being once the property of King Robert Bruce. But I must be indulged in some particulars to which I cannot speak with absolute certainty, as so much time hath elapsed since the transaction I am going to relate.

"Being early fond of any thing ancient or uncommon, I used to purchase pieces of old coin from a goldsmith who wrought privately in Glasgow, and sometimes went about as a hawker. Having often asked him, from the curiosity of a boy, if he had ever been at the castle of Clackmannan, or heard of any antiquities being found there, he told me, that he had purchased from Mrs. Bruce—who is the only survivor of that ancient family in the direct line—an old watch, which was found in the castle, and had an inscription,

bearing, that it belonged to King Robert Bruce. I immediately asked a sight of it; but he told me it was not at hand. He fixed a time for showing me this invaluable curiosity; but even then it could not be seen. My avidity produced many anxious calls, although by that time I began to suspect he meant to play upon me, especially as I did not think it altogether credible that Mrs. Bruce would sell such a relique of her family, if she had ever had it in her possession. At length I was favoured with a sight of it. The watch, as far as I can recollect, almost entirely answered the one described. It had a ground of blue enamel. It had a horn above the dial-plate instead of a glass. The inscription was on the plate: but whether it was *Robertus B.* or *Robertus Bruce*, I cannot remember. The watch was very small and neat, and ran only, to the best of my knowledge, little more than twelve hours: Mr. Barrington does not mention any thing about this circumstance. It is about twelve years since I saw it. Whether there be any castle in Fife, properly called Bruce Castle, I know not; but the castle of Clackmannan hath

always been the residence of the eldest branch of the family; and although the town in which it stands now gives name to a small county, yet in former times, and still in common language, that whole district receives the name of Fife, as distinguishing it from the county on the other side of the Firths of Forth and Tay. The first thing that occurred to me about the watch itself, was in regard to the inscription. Observing that all the coins of King Robert's age bore Saxon characters, I could not believe the inscription to be genuine, because the characters were not properly Saxon, but a kind of rugged Roman, or rather Italic characters, like those commonly engraved, but evidently done very coarsely to favour the imposition. He valued it at thirty shillings; but I would have nothing to do with it. The first time I had an opportunity of seeing Mrs. Bruce of Clackmannan, after this, I asked her if such a watch had ever been found. She told me, that she never so much as heard of any such thing. This confirmed the justness of my suspicion.

"I paid no further regard to this story till

about seven years ago, when I received a letter from a friend, informing me that a brother of his in London, who had a taste for antiquity, had desired him, if possible, to procure some intelligence from Glasgow about a watch, said to be King Robert Bruce's, which had thence found its way to London, and was there making a great noise among the antiquaries. I then applied to my former goldsmith, who was then in a more respectable way, and mentioned the old story. He immediately fell a laughing, and told me, that he did it merely for a piece of diversion, and thought the story would take with me, as I had been often asking about the place. He said it was an old watch brought from America; that, to get some sport with my credulity, he had engraved the inscription on it in a rough, antiquated-like form; that he had afterwards sold it for two guineas: he had learned that it was next sold for five, and had never heard more of it.

"However early the invention of clocks might be, I am greatly mistaken if any authentic documents can be produced of the

art of making pocket-watches being discovered so early as the fourteenth century. Lord Kaimes, somewhere in his sketches of man, asserts, that the first watch was made in Germany, so far as I can remember, near the close of the fifteenth. If any watch had been made so early as R. Bruce's time, it is most likely the inscription would have been in Saxon characters, as not only the money both of Scotland and England, but of Germany, in that age, bears a character either Saxon, or greatly resembling it."

The mechanism of that common piece of household furniture, the kitchen jack, approaches so nearly to that of a clock, that it may without impropriety be mentioned under the same head. We have no account of the exact period of its first invention; but Montaigne mentions his having seen one at Brixen, in the Tyrol, in 1580, and describes it as a new discovery. He tells us, that it was kept in motion by a weight, in the same manner as clocks, and that when wound up it turned the spit for a whole hour. He had previously seen, in some other place, another, turned by smoke; and it would appear that

the latter is the older of the two: for in a very scarce book on culinary subjects, published in 1571, by Bartolomeo Scappi, cook to Pope Pius V., there is a description, accompanied with an engraving, of the smoke-jack; but no mention whatever of a jack moved by weights.

CORN-MILLS.

ANCIENT MODE OF GRINDING;—WATER-MILLS;—TIDE-MILLS;—IMPROVEMENT IN THE ART OF GRINDING;—EXPERIMENTS ON THE PRODUCE OF WHEAT;—MILL-STONES.

In the remote ages of antiquity, corn was rather pounded than ground; and the hand-mills of which we read in the Scriptures were, probably, not very different from the pestle and mortar still in use. They required so little strength in management, that grinding was then the occupation of women; but afterwards, when they were enlarged, and improved by the addition of a cross-handle to the pestle, by means of which it was turned, they were worked by bondsmen, around whose necks was fixed a piece of wood, so constructed as to prevent them from putting their hands to their mouths, and consequently from eating the meal.

In process of time, shafts were added to these machines, and they were driven by cattle. In the opinion of Beckmann, the oldest cattle-mills resembled that described in Sonnerat's voyage to the East-Indies, in which the pestle of a mortar, fastened to a stake driven into the earth, is affixed to a shaft, to which two oxen are yoked: they are driven by a man, and another stands near the mortar to put the grain under the pestle.

There are various passages in ancient authors in which hand and cattle-mills are spoken of, which it would be uninteresting to detail: but it appears from them, that the first certain information we have of the invention of *water-mills*, is not older than the time of Julius Cæsar; and that, the first of these was erected on the Tiber, a short time previous to the reign of the Emperor Augustus. Cattle-mills, however, continued in such general use, that near three centuries afterwards there were more than three hundred at Rome; many of which were driven by asses. The first mention of *public* water-mills which occurs in the Roman laws, dates

in the year 398, when some enactments were made, which show that they were even then considered as a new establishment.

These mills were situated on the aqueducts which supplied Rome with water; and as these were cut off when the city was besieged by the Goths in 536, Belisarius, who commanded the garrison, caused boats to be moored in the Tiber, on which he erected mills, which were driven by the current. To this experiment therefore, is to be attributed the origin of *tide-mills.*

It has been generally supposed that *wind-mills* were invented in the East, and introduced into Europe by the Crusaders: but this is so far from probable, that, even at the present day, mills of that kind are rarely found in either Persia, Palestine, or Arabia; and besides, wind-mills were in use on the Continent as early as the time of the first Crusade, and were common in the twelfth century. But these mills were for a long time constructed with an immoveable frame, and could only work when the wind was in one quarter. At present either the whole building turns on a pivot, or the roof alone

with the axle-tree and sails are moved in the same manner, as the wind changes: an improvement which is attributed to either the Dutch or Germans, about the middle of the sixteenth century.

Among the many rights enjoyed by the feudal lords, was that of *ban-mills;* that is, of mills at which the vassals were obliged to grind their corn, for which they paid toll in kind. The oldest mention of these occurs in the eleventh century. We must not, however, attribute the exercise of this right wholely to oppression: the building of mills was always expensive, and was then considered as an undertaking of such magnitude, that those who erected them stipulated with the neighbourhood for the exclusive privilege of grinding, as an indemnification; but it cannot be denied that it was often unjustly exacted, and it is to this day a subject of grievance on many parts of the Continent.

The protection which society demands for property, rendered it necessary that enactments should be framed to prevent such use of common streams as might impede their general utility: wherefore individuals were

restrained from erecting water-mills until it should have been declared, upon proper investigation, that they were not injurious. But the cupidity of some governments converted this equitable regulation into a monopoly, and not only were these mills included among the Regalia, or rights of the crown, but these were extended over the air; of which the following whimsical instance is recorded in the Chronicles of the Monastery of Augustines, at Weindsheim, in the province of Overyssel.

The Monks, it seems, were desirous of erecting a wind-mill in the neighbourhood of Zwoll; but the lord of the soil opposed their intention, on the ground *that the wind in that district belonged to him!* Upon this the Monks had recourse to the Bishop of Utrecht, who decided, "in a great passion," that no one had power over the wind in his diocese, *but himself!* And he, accordingly, granted letters patent to the holy fathers.

An account of the construction and management of corn-mills is both foreign to the intention of this brief essay, and would afford but little of either instruction or en-

tertainment to the generality of readers; but it is not unworthy of remark, that by the manner of grinding commonly adopted in France so late as the middle of the last century, more than half the corn was, if not actually wasted, at least unproductive of meal, and considered as refuse. In consequence of experiments made from 1764 to 1768, the present method was adopted, by which the Paris setier of about $4\frac{1}{3}$ bushels Winchester measure, which before that time yielded only 80 to 90lbs. of flour, and 150 to 160 of bran, was made to produce 185, and afterwards even 195lbs. of fine flour. This improvement consisted in nothing more than first grinding the corn coarsely, and afterwards passing it several times through the mill, and through various sieves: it was, indeed, by no means a new invention, and was not unknown even in France, but the millers were prohibited under severe penalties from adopting it, from a mistaken notion that it was prejudicial to health. The extraordinary influence which it must have had upon political economy, is evinced by the fact, that previous to its adoption, the annual consump-

tion of each male adult, was calculated at four to five setiers of wheat, and now at only two.

In England, from six and a quarter to six and a half bushels of wheat are supposed to produce the sack of fine flour of two hundred and eighty pounds, from which are made eighty-four quartern loaves of the assize weight of four pound five ounces.

In America, where the art of mealing is presumed to be carried to great perfection, the following experiments have been made, from which some idea may be formed of the difference of product in various qualities of wheat:—

Weight per bush.	Superfine flour.	Tail flour and middlings.	Ship stuff.	B. Stuff, Shorts & Bran.	Screening and loss.	Quality of the Grain.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
59 5	38 5	3 68	2 5	13 1	1 72	White, clean.
59	40 23	3 65	2 12	12	1	Do. well cleaned.
56	35 81	5	1 85	7 86	5 48	Do. very clean.
60	38 7	3 6	1 61	8 52	7 57	Red, not well cleaned.
59 25	35 26	4 4	1 47	11 28	6 79	Do. mixed with cockle and light grains.

From experiments accurately made in the latter country, it has also been found that the finest flour, or even that reduced to an im-

palpable powder, makes the lightest as well as the best bread; which is contrary to a very generally received opinion in England.

It is also an interesting fact that, in one year, a ton of sand, at least, is supposed to be rubbed off from a pair of mill-stones; and this sand, being of the finest nature, passes through the sieves with the flour, and is consequently used along with it. Whence it has been calculated that, supposing each pair of stones to grind no more than four thousand four hundred bushels of wheat annually, and each individual to consume eight bushels, a man thus swallows about four pounds of pulverized stone every year.

COTTON MANUFACTURE.

ANCIENT USE OF COTTON CLOTH;—SERICA;—BOMBYCINA;—TRADE BETWEEN ROME AND INDIA;—COTTON MANUFACTURE IN MALTA;—AND IN EUROPE DURING THE MIDDLE AGES;—INDIAN LOOM;—THREAD WHEEL; SPINNING JENNY;—SIR RICHARD ARKWRIGHT'S IMPROVEMENTS;—MULE;—INCREASE OF THE COTTON MANUFACTURE IN ENGLAND;—IMPORTS OF COTTON DURING THE LAST HALF CENTURY.

COMMENTATORS on the writings of the ancients have generally supposed that the stuffs called by Latin authors *bombycina*, and *serica*, were composed of a mixture of silk and wool; and they seem to have considered the terms as indiscriminately denoting a similar substance. The texture of this, we learn, was so thin, that an old writer humorously says, in allusion to it:—

"*Æquum est induere nuptam ventum textilem,*
Palam prostare nudam in nebula linea!"

"A woven wind should married women wear,
And naked in a linen cloud appear!"

and Seneca mentions that he had seen ladies dressed in robes so transparent, that they scarcely concealed the charms they covered: *video sericas vestes—si vestes vocandæ sunt—in quibus nihil est quæ defendi corpus aut denique pudor possit: quibus sumptis mulier parum liquido nudam se non esse jurabit. Hæc ingenti summa ab ignotis etiam ad commercium gentibus accersuntur, ut matronæ nostræ ne adulteris quidem plus sui in cubiculo quam in publico ostendant.*

We find, indeed, nearly the same description in various passages, and Juvenal accuses even a learned judge of appearing thus dressed, upon the bench:—

——— "Lo! robes, which misbecome
A witness, deck the awful bench of Rome;
And Creticus, stern champion of the laws,
Gleams through the tissue of pellucid gauze!"
Sat. II.

His learned translator, Mr. Gifford, who has thus rendered the passage, observes, in com-

menting upon it, that the "*sericæ vestes* were what we call fine cottons, imported into Europe in Juvenal's time, as they were ages before, from India, through the country of the Seres, the modern Bochara. *Bombycinæ vestes*, on the contrary, were of silk, and from *Sinæ* (China), a region much more remote. It is not easy to say when the use of these vests was first introduced into Rome; no mention of them occurs during the times of the old republic, so that they probably crept in, with other luxuries, under the emperors."

Considering that there was a regular commercial intercourse established through the medium of Egypt between Rome and India, the chief mart of which was on the coast of Malabar, which has been ever celebrated as the greatest manufacturing district of the East, and that the art of weaving was practised there at the remotest period of which we have any account, it is by no means improbable that Mr. Gifford's conjecture as to the use of cotton cloth in Rome is correct; that respecting the part of the Eastern continent whence it was obtained is more liable to doubt, but it is strongly corroborated by

some lines in the Georgics of Virgil, which seem evidently to allude to the cotton plant:—

> " *Quid nemora Æthiopum, molli canentia lanâ,*
> *Velleraque ut foliis depectant tenuia Seres.*"
>
> " Of Æthiop's hoary trees and woolly wood,
> Let others tell: and how the Seres spin
> Their fleecy forests in a slender twine."
>
> *Dryden, Georg. II.*

From the East the cotton plant found its way to the island of Malta, and its produce was manufactured there at a very early period. The island is celebrated for producing that species which is naturally of the Nankeen colour, and stuffs of considerable fineness are woven from it at the Citta Vecchia. There is also a considerable manufactory of light coverlids; but the chief trade consists in the export of cotton thread to Spain. Of the continuance of this manufactory after the subversion of the Roman Empire, and during what are termed the middle ages, there are no certain accounts; nor is it known that the cotton plant was cultivated during that æra in any part of Europe. The introduction of cotton in an unmanufacured state,

for the purposes of weaving, is of comparatively modern date, and it is only within the last half century that it has become an object of importance in this country.

The original loom, which is still used in India, probably without alteration of the form in use during the earliest age of its invention, consists merely of two bamboo rollers, one for the warp, the other for the web, with a pair of geer, and the shuttle performs the double office of the batton. This simple apparatus the Indian weaver frequently erects under the shade of a tree. He digs a hole large enough to contain his legs, and the lower part of his geer; he then stretches the warp by fastening the rollers at due distance in the turf, and suspends the balances of the geer from the spreading branches of the tree; two loops beneath the geer, into which he inserts his great toes, serve instead of treddles; and with his long shuttle he both draws the weft, throws the warp, and afterwards closes it up to the web. In such primitive looms as this are made those admirable muslins, the softness and delicacy of which have not even yet been

equalled by all the complicated improvements of European machinery. The spinning is still performed by the ancient operation of the distaff.

In England, where the cotton manufacture has been brought to greater perfection than in any other part of Europe, the spinning has been variously performed. The most simple method, and the only one in use during a long time, was by means of a well-known domestic machine, called the one-thread wheel; but as the demand for cotton cloth increased, other inventions were thought of for facilitating this operation. About seventy years ago, the first patent for a more easy and expeditious method of spinning cotton was obtained by a person of the name of Paul; but the undertaking did not prove successful. Some years after, various machines were constructed for the same purpose by different persons, but without effecting any very material improvement. At length, about the year 1767, Mr. James Hargrave, a weaver in the neighbourhood of Blackburn, in Lancashire, contrived a machine by which a great

many threads could be spun at once, for which he obtained a patent under the name of the "spinning jenny:" it was worked by hand, and when brought to perfection, one person could spin with it at once eighty-four threads, and make, in the course of a day, one hundred hanks of eight hundred and forty yards each.

The next, and most important improvement in this branch of the manufacture was made by Mr.—afterwards Sir Richard—Arkwright, of Cromford, in Derbyshire. His first patent was obtained in 1769, and he afterwards, in 1775, obtained another: but one of these was afterwards set aside in consequence of some legal defect, and he had for a long time to contend against a series of unforeseen difficulties. He at length, however, succeeded in establishing the celebrated machine called the "mule," from being composed partly of the machinery used in the hand-jenny. It is worked entirely by machinery, and is now exclusively employed in the manufacture of cotton thread, or, as it is technically termed, twist.

Although the name of Sir Richard Arkwright is doubtless familiar to most of our readers, as the inventor of great improvements in the art of spinning cotton,* and they are probably aware that to his improvements the kingdom is chiefly indebted for the extensive manufactories which it now possesses, it will yet, we should presume, be interesting to many to have some data from which they may judge of the importance of this branch of national industry; we therefore annex a statement, in round numbers, of the average annual imports, for every ten years during that period:—

From 1771 to 1780 inclusive,	5,725,000 lbs.
1781 . 1790 . . .	18,200,000
1791 . 1800 . . .	32,000,000
1801 . 1810 . . .	70,000,000
1811 . 1820 . . .	105,000,000

The imports of the last five years of the above series exhibit a still more rapid increase, the annual average being 144,000,000 of pounds, and the annual consumption up-

* For the origin of Sir Richard Arkwright's improvements, see vol. i. b. i. p. 171.

wards of two and a half millions weekly. The above view presents a phenomenon not easily parallelled in the history of commerce, and shows what influence the exertions of a single individual may have on the welfare of nations.

DIVING-BELL.

ANCIENT EMPLOYMENT OF DIVERS;—INVENTION OF THE DIVING-BELL; — SPANISH ARMADA; — PHIPPS' ADVENTURE;—DIVING-BELL OF DRS. HALLEY, SPALDING, TRIEWALD, AND SMEATON;—APPARATUS FOR WALKING UNDER WATER; —MACHINERY FOR RAISING PROPERTY FROM THE ABERGAVENNY EAST-INDIAMAN.

Swimming is at once so necessary and so attractive an exercise, that it naturally led to the practice of diving, and the habit of remaining under water for an unusual period was easily acquired. Professed divers were formerly kept in ships, to assist, as it would seem, in raising the anchors; and, by the laws of the Rhodians, they were allowed a salvage on goods which had been thrown overboard, proportioned to the depth from which they were raised. In war, they were

employed to destroy the ships of the enemy; and the pearl fisheries in the Indies were conducted by divers, in the time of the Greeks and Romans, in the same manner as at the present day: these sometimes continued under water during a quarter of an hour, and instances are recorded of some who have remained still longer.

At a very early period, means were contrived to supply divers with air while under the water; and with this view the diving-bell was invented. The idea which led to it was probably suggested by the following simple experiment: if an inverted drinking-glass be immersed in water, with the precaution to keep its edges on a level with the surface, the glass will not become filled with water, although pressed down to the greatest depth, because the air cannot be expelled by it. In the same manner, if a bell of metal be so constructed as that the diver can stand on a plank suspended below it, the upper part of his body, being enclosed by the bell, will be protected from the water; and, even at the bottom of the ocean, he may breathe the air confined within the cavity.

The invention of this machine is usually attributed to the sixteenth century. Aristotle, indeed, makes some allusion to a kind of kettle used in his time to enable divers to continue under water; but it is not described. The oldest information which can be relied upon respecting its actual employment, is the account of an experiment tried at Toledo, in the year 1538, before the Emperor Charles V. and many thousand spectators, when two Greeks descended into the water in a very large inverted kettle, in which there was also a candle burning, and rose again without being wetted. The kettle was equipoised with lead at the mouth, so that, when let down, no part of its circumference should touch the water sooner than another.

From this time the use of the diving-bell seems to have been well understood, and it is frequently mentioned in the works of Sir Francis Bacon. It was made use of about the middle of the seventeenth century, to assist in raising the treasure which was supposed to have been sunk in that part of the celebrated Spanish Armada which was wrecked on the western coast of Scotland,

in 1588; but some cannon only were obtained, which were not sufficient to defray the expenses. The same experiment was repeated, in 1688, by a company, at the head of which was the Earl of Argyle, but it was attended with very little success. Previously to this last, it had been tried on the wreck of a rich Spanish vessel which had been sunk on the coast of Hispaniola, and the circumstances attending the undertaking are sufficiently curious to merit detail.

The loss of this ship, which was known to contain a vast treasure, induced one William Phipps, who was the son of a blacksmith, in America, and had been himself bred up as a ship carpenter, at Boston, to propose a plan to King Charles II. for raising the bullion with which she was freighted. The monarch, little scrupulous in such matters, approved the project, and furnished Phipps with a vessel and every thing necessary for the undertaking. He sailed on this expedition in 1683, but after various ineffectual efforts, he returned to England in great poverty, but still with a firm persuasion of the practicability of his scheme. But failing in his

endeavours to prevail on King James II., who had then succeeded to the throne, to assist in its further prosecution, he had recourse to a public subscription, which, after considerable difficulty, he obtained through the aid of the Duke of Albemarle, who himself advanced a large sum towards it, and on condition of dividing the profits with the subscribers. In 1687 he once more set out to try his fortune, in a ship of two hundred tons; and after being reduced almost to despair by repeated fruitless trials, and just as he was on the point of abandoning the enterprize, he at length succeeded in raising, from a depth of between six and seven fathoms, such a quantity of the treasure, as produced in England, two hundred thousand pounds sterling. Of this sum his own share amounted to about twenty thousand pounds, and that of his patron the Duke of Albemarle to ninety thousand pounds. It further appears that some persons endeavoured to persuade the King to seize the ship and cargo, under pretence that Phipps had made some misrepresentation in his original plan; but his Majesty rejected the

advice with indignation, and conferred on Phipps the honor of knighthood.

This machine has been used for similar purposes, at various subsequent periods, and numerous improvements have been made on the original invention, none of which, however, merit particular attention, except those of the late ingenious Dr. Halley, and of a Swede named Triewald.

The diving-bell constructed by order of Dr. Halley was three feet broad at the top, five at the bottom, and eight in height; forming a cavity of sixty-three cubic feet. It was covered with lead: around the mouth, weights were so arranged as that it could not remain in an oblique position, but must necessarily sink in a perpendicular direction; and it was so heavy, that it sank to the bottom even when empty. In the top, there was a piece of crystal glass to admit light, and a valve to allow of the escape of foul air. Around the interior circumference of the mouth, there was a seat for the divers, and a plank, secured by ropes, hung below, on which they could stand when at work. The entire machine was suspended from the yard

of a ship, and could be lowered into the water, and hoisted up again, at pleasure. In order to supply it with fresh air while under water, vessels filled with air, and in which was an opening at the bottom through which the water compressed the enclosed air, were let down along with it. In the top of these was a leather pipe besmeared with oil, through which the air might be introduced into the bell; and so soon as one was emptied, it was drawn up, on a signal from the diver, and another was lowered. The corrupted air, in the bell, being, from its warmth, the lightest, escaped through the valve; and thus the machine was continually supplied with fresh air, in such quantity, that Halley and four other persons continued under water during an hour and a half, at the depth of ten fathoms, nor was there any limit to the period which they might have remained with equal safety. The sole inconvenience experienced was a pain in the ears, as if a quill had been thrust into them: the sensation was only momentary, but returned whenever the bell was let down to a greater depth. One of the divers, thinking to prevent this, filled his ears

with chewed paper, but the air forced it into them so far that it was extracted with considerable difficulty.

With this apparatus Dr. Halley was enabled to keep out the water so effectually, that, at the bottom of the sea, the soil did not rise above his shoe. The glass in the top admitted so much light, when the sea was quite still, that he could read without difficulty; but in stormy weather, the rolling of the waves rendered the bell quite dark; he then kindled a light; but a candle consumed the same quantity of air as a man. He wrote his orders to those above with an iron spike upon a plate of lead, and sent them up when the air vessels were raised, by which means he directed the removal of the bell from one place to another. He also contrived a leaden cap which covered the entire head, and was supplied with air from a flexible pipe communicating with the bell, and with this he could send a diver several fathoms around it when at the bottom of the ocean. These contrivances were, however, liable to many objections; among the most serious of which were, the possibility of the

bell being overset, by coming into contact with any unexpected obstruction below the water, and the danger of the rope by which it was suspended breaking before it could be drawn to the surface. These inconveniences were remedied by the ingenuity of Mr. Spalding, of Edinburgh, who added a balance weight, which, hanging a considerable way below the mouth of the bell, preserved its equilibrium in case of its meeting with any obstacle in its descent, and provided against accident by the failure of the rope in the following manner:—

The bell is divided into two separate cavities, both of which are made as tight as possible. Just above the second bottom, are small slits in the sides, through which the water, entering as the bell descends, displaces the air originally contained in its cavity, which flies out at the orifice of a cock contrived for that purpose. When this is done the divers stop the cock, so that if any more air was to get into the cavity, it could no longer escape as before. When this cavity is full of water the machine sinks; but when a considerable quantity of air is admitted, it

rises. If, therefore, the divers wish to raise themselves, they turn another cock, by which a communication is made between the upper and the under cavities of the bell. The consequence of this is, that the air immediately rushes into the upper cavity, forces out a quantity of the water contained in it, and thus renders the bell lighter by the whole weight of the water which is displaced. Thus, if a certain quantity of air be admitted into the upper cavity, the bell will descend very slowly; or if a greater quantity, it will remain stationary; and if a still larger quantity, it will rise to the surface: and thus the divers can raise the machine at their pleasure, and be still safe, although the rope to which it was appended should be broken.

The improvement of Triewald consisted in little more than placing the diver in such a position that his head alone rose above the surface of the water within the bell; which situation has the advantage of the air being cooler, and, consequently, fitter for respiration than at the upper part of the machine: and in some minute, and rather complex, arrangement of the air-pipe.

The late ingenious Mr. Smeaton's diving-bell was a square chest of cast-iron, four feet and a half in height, and in length, and three feet wide; affording room for two men to work in it. It was supplied with fresh air by means of a forcing pump, and was used with great success.

Although not strictly a diving-bell, it must not be omitted, that an Englishman invented an apparatus of very strong leather, so prepared, as that air could not escape through it, and so constructed, as to fit the limbs while it covered the entire body, and yet, having a glass in front, did not obstruct the sight. It contained half a hogshead of air, which afforded a supply for a considerable length of time; and when thus equipped, he could not only walk at the bottom of the sea, but enter into the various parts of a sunken ship. He is said to have followed this occupation for more than forty years, and to have acquired a considerable fortune.

The machinery contrived to raise property from the Abergavenny East-Indiaman, which was sunk a few years ago near Weymouth, consisted of a body of copper with iron boots

and joints, as in a coat of mail. The whole was then covered with leather, and afterwards with canvas painted white to distinguish it in the water. The arms were made of strong water-proof leather, and the aperture for sight was about eight inches in diameter, glazed with crystal glass an inch thick. The diver was sunk by means of weights fastened equatorially round the waist of the machine, and he was suspended by a rope with which his situation could be changed at pleasure.

FIRE-ARMS.

EARLIEST USE OF ARTILLERY;—EXTRAORDINARY CANNON OF MAHOMET II.;—TURKISH HOWITZERS;—INVENTION OF MUSKETS;—FIRE-LOCKS;—AURUM FULMINANS;—PISTOLS.

It is a generally received opinion, that artillery was used by Edward III. at the battle of Crecy; but if so, it is a singular circumstance that Froissart, a contemporary historian, should have omitted to notice a fact of so much novelty and importance. We have, however, the decisive testimony of a passage in the works of Petrarch—who execrates this terrestrial thunder—that they were common before the year 1344: "*nuper rara, nunc communis.*"

The most extraordinary cannon of which there is any account in history, both for its

size and the period when it was employed, was used by the Sultan Mahomet II. at the siege of Constantinople, in 1453. It was cast at the foundry of Adrianople, by a Dane or Hungarian, of the name of Urban, who had deserted from the service of the Greek Emperor Constantine Palæologus; and is thus described by Gibbon: "At the end of three months, a piece of brass ordnance was produced, of stupendous, and almost incredible magnitude; a measure of twelve palms is assigned to the bore; and the stone bullet weighed above six hundred pounds. A vacant place before the palace was chosen for the first experiment; but, to prevent the sudden and mischievous effects of astonishment and fear, a proclamation was issued, that the cannon would be discharged the ensuing day. The explosion was felt or heard in a circuit of an hundred furlongs; the ball, by the force of gunpowder, was driven above a mile; and on the spot where it fell, it buried itself a fathom deep in the ground. For the conveyance of this destructive engine, a frame or carriage of thirty waggons was linked together, and drawn

along by a team of sixty oxen: two hundred men on both sides were stationed to poise and support the rolling weight; two hundred and fifty workmen marched before to smooth the way, and repair the bridges; and near two months were employed in a laborious journey of one hundred and fifty miles."

Voltaire, indeed, has ridiculed the credulity of the Greeks, in recording the account of this tremendous gun; and calculates, that a ball of only two hundred pounds would require a charge of one hundred and fifty pounds of powder, while the impetus received from it could be but feeble, since not a fifteenth part of the mass could be inflamed at the same moment. But the positive and unanimous evidence of contemporary writers is not to be lightly rejected; and we learn from the Memoirs of the Baron de Tott, that the Turks still possess a cannon still more enormous than that already described, from which a stone bullet of eleven hundred pounds weight was once discharged with three hundred and thirty pounds of powder: at the distance of six hundred yards it shivered into three fragments, traversed the strait

of the Bosphorus, and leaving the waters in a foam, again rose and bounded against the opposite hill. It is, indeed, well known that the entrance of the Dardanelles is, at this moment, guarded by artillery of still greater calibre than that of Mahomet. These guns, if indeed they may be so called, are of that description termed howitzers: they are merely excavations in the solid rock, and as their elevation cannot, consequently, be altered, they are only of service against that particular point to which they remain unalterably directed; but the power of the shot, when it does take effect, is terrific, as was sensibly experienced by the British fleet on its attempt to force the passage during the late war.

The invention of portable fire-arms would appear to have originated in Germany, which, indeed, seems sufficiently proved by the circumstance that the old names by which the different kinds were distinguished, were all, either German, or immediately derived from that language. They were originally called *büchse,* and then *hakenbüchse*: whence the French took their *harcquebouzes,* which, in the modern dialect, we call *arquebuse,* and

has also been adopted in the English *harquebuss.* These were the original musquet; but so long and heavy, that they could not be conveniently fired from the hand alone, and, therefore, when it was necessary to use them, they were placed on a prop, with a fork at the top, between which the piece was fixed by means of a hook projecting from the stock. They were first used at the siege of Parma, in 1521, and there is still one preserved, in perfect order, in the arsenal of Dresden; but the invention is, no doubt, of an earlier date, for it is supposed that gun-locks were invented in the city of Nuremburgh, in 1517.

The term musquet is said to have been taken from the Latin *muschetus,* an appellation for a species of the male sparrow-hawk; and this derivation is the more probable as the *falconet* and other arms were named after voracious animals. It has been proved that this arm was known in France so early as the reign of Francis I., although it has been asserted by Brantome, in his Memoirs, that it was first employed in the army of the Duke of Alva, in the Netherlands, in 1567.

He states, that there was at first great difficulty in accustoming the soldiers to its use; and he adds—what we may readily believe—that "*ces mousquets étonnèrent fort les Flammands, quand ils les sentirent sonner à leurs oreilles.*"

The first muskets were discharged by means of a match applied with the hand; but this was afterwards adjusted to a cock, for greater security and precision in shooting. Instead of the match, which was in many respects inconvenient, and subject to be extinguished, a fire-stone was, at a later period, screwed into the cock, and sparks were struck from it by means of a small wheel, which was wound up with a key applied to the barrel. The stone at first employed, however, was not flint as at present used, but a compact pyrites or marcasite, and, as this was apt to miss fire, the match continued for a long time to be used along with it, and flint-locks do not seem to have entirely superseded the match-lock in the Continental armies, until towards the close of the seventeenth century. We have already mentioned, that the first gun-lock was invented in 1517;

but there is no account of the form of its construction; and the old *büchse*, in the arsenal at Dresden, instead of a lock, has a cock with a flint placed opposite the touch-hole, which flint, it appears, was rubbed with a file until a spark was elicited: the term fire-lock was given to the invention which is still in use, and it was applied to the gun itself, in order to distinguish it from that which was fired by a match-lock.

An ingenious discovery has lately been made, by which the powder of *aurum fulminans** has been rendered applicable to the discharge of fire-arms. A cylinder has been contrived, which contains several cavities, and which revolves upon an axis fixed at right angles to the barrel; these cavities are filled with the powder, and each is brought successively opposite to the touch-hole by means of a key: the trigger, instead of moving a cock with a flint, impels a small peg which strikes upon the aurum fulminans, which, as it explodes by the mere force of percussion, instantly inflames the gunpowder

* "*Aurum fulminans.*"—See art. "Fulminating Powder." B.iv.

in the barrel. The lock is thus secured from the effects of damp, and the piece is primed, at once, for several discharges.

Pistols are first mentioned in France about the year 1544; but they are said to have been used at an earlier period in Germany, and were employed as an arm belonging to certain German cavalry, who were thence called *pistoliers*. The origin of the name, however, has not been ascertained: some have derived it, and with much appearance of probability, from *Pistoia* in Tuscany, where it is said they were first made; and others from *pistillo*, and *stiopo*, from the large knobs which terminated the handles. They seem to have been originally formed entirely of iron; and the locks were constructed with a wheel, in the manner already described. Several of these are preserved in ancient collections of arms: amongst those in the arsenal at Hanover, is one entirely of brass; and the date upon that considered as the most modern is 1606.

FIRE ENGINES.

INVENTION OF PUMPS;—CONJECTURES RESPECTING FIRE-ENGINES;—SIPHONES;—FIRES IN ANCIENT ROME.

THE invention of pumps is ascribed, on the authority of Vitruvius, to Ctesibius, who lived at Alexandria in the time of Ptolemy Philadelphus and Ptolemy Evergetes, consequently about two centuries before the Christian æra. It seems probable, also, that he had conceived the idea of applying the principle to fire-engines, for his pupil, Hero of Alexandria, expressly mentions this use, and describes the construction of a forcing-pump with two cylinders. It is, however, doubtful whether this application of it soon became general, or indeed, whether it was known to the ancient Romans; but the following data

are in favor of the probability that they were acquainted with some similar machine.

Among the letters from the younger Pliny to the Emperor Trajan, there is one in which he informs him that the town of Nicomedia, in his government of Bithynia, had been destroyed by fire; and adds, that the conflagration had been spread by a violent storm which took place at the time, by the inertness of the inhabitants, *and by the want of proper instruments for extinguishing the flames.** The word *sipho,* which is the term of which he makes use, can only be construed, in that passage, as meaning a fire-engine, though some commentators understand its general signification to mean only the aqueducts and pipes for distributing water throughout the city; and Pliny also mentions buckets, which are usual appendages to that machine.

Apollodorus, the architect, who was cotemporary with Pliny, and was employed by the Emperor Trajan in constructing the celebrated bridge over the Danube, and in erecting some large works at Rome, also describes

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* Plin. epist. lib. x. ep. 42.

how assistance may be rendered when the upper part of a house is on fire, *and the machine called sipho is not at hand.* In this case, he directs that hollow reeds are to be fastened to leathern bags filled with water, in such manner as that, by pressing the bags, the water may be forced through the reeds and projected to the place in flames; from which we may collect, that the *sipho*, for which this apparatus was a substitute, was capable of throwing water to a considerable height.

That fire-engines, properly so called, were designated by the term *siphones* in the fourth century, is fully proved by the writings of Hesychius; and also by those of Isodorus, who lived in the seventh century. It still, however, remains to be proved at what period they were introduced into ancient Rome; and on this point no satisfactory data have been collected. It is well known that the buildings in that city were exceedingly lofty, and the lanes, and even the principal streets, extremely narrow; also that fires were frequent; and yet no mention is made in the Roman laws, among the numerous ordi-

nances for preventing accidents by fire, of any machine for that purpose. Seneca says, that the height of the houses rendered it impossible to extinguish the flames when they were on fire; but Juvenal mentions, in his general description of a fire at Rome, that water was used for extinguishing it, and we can hardly suppose that he alluded to its being merely thrown with buckets :—

> "*Vivendum est illic, ubi nulla incendia, nulli*
> *Nocte metus: jam poscit aquam, jam frivola tranfert*
> *Ucalegon: tabulata tibi jam tertia fumant:*
> *Tu nescis.*"
>
> *Sat. III. v.* 181.

> "O! may I live where no such fears molest,
> No midnight fires burst on my hours of rest!
> For here 'tis terror all: midst the loud cry
> Of 'water! water!' the scared neighbours fly,
> With all their haste can seize. The flames aspire,
> And the third floor is wrapt in smoke and fire,
> While you unconscious doze."—*Gifford.*

GILDING.

ANCIENT MODE OF GILDING;—MOSAIC TABERNACLE;—MUMMIES;—ROMAN GOLD-LEAF;—GOLD-BEATER'S SKIN;—COURT-PLASTER; — DUCTIBILITY OF GOLD; — COLD GILDING; — FALSE-GILDING; — GILT PAPER AND TAPESTRY;—ALEXANDER THE IMPOSTOR;—PRIESTS OF BACCHUS.

THE extreme ductibility of gold induced people, at a very remote period, to attempt the reduction of it into thin plates, for the purpose of overlaying and ornamenting various articles. It is proved by Herodotus* that the Egyptians were accustomed thus to cover wood and metals; and Homer details the process employed for gilding, in this manner, the horns of a cow brought by Nestor, as a present to Minerva.† Gilding is

* Herod., lib. ii. 63.

† Homeri Odyssea., lib. iii. v. 432.

also frequently mentioned in the Old Testament, more especially in the books regarding the construction of the Tabernacle. It is, however, uncertain whether the method thus employed is to be considered as that which we term gilding—merely with gold-leaf, or covering the substance to be ornamented with plates of gold. In deciding this point we have little beyond conjecture to guide us; but it has been justly remarked that, if plates had been used, the Mosaic Tabernacle would have been too heavy to be carried in the manner directed in the Scriptures, on the shoulders of men. Stronger arguments than this are, that the quantity of gold possessed by Moses does not appear, according to the best calculations that have been made of its supposed value, to have been sufficient for all the purposes for which it was employed, unless gilding alone had been resorted to;*

* "All the gold that was occupied for the work, in all the work of the holy place, even the gold of the offering, was twenty and nine talents, and seven hundred and thirty shekels, after the shekel of the Sanctuary." Exod. ch. xxxviii. v. 24. The highest valuation that has been made of this quantity does not exceed 300,000 ducats, or about £150,000 sterling.

and that, even the thinnest plates could not, without great difficulty, have been so fastened on the figures and carved work, as to exhibit them with the accuracy mentioned in the first book of Kings: "*and he carved thereon cherubims, and palm trees, and open flowers; and covered them with gold, fitted upon the carved work.*"* It may also be observed, that the Hebrews might perhaps have acquired the art of gilding in Egypt, where it seems to have been very early understood, for it is found on mummies, and in the very oldest temples; and although the antiquity of the former is doubtful, yet we find allusions to them in the Scriptures.† It also appears that, even in the time of Moses, there was some distinction made between gilding and overlaying with plates of gold; but it is not sufficiently clear to enable modern commentators to determine how far the difference extended.

In the time of the elder Pliny, in the middle of the first century of the Christian æra,

* Kings, ch. vi. v. 35.

† See the article *Museums*, b. 1. v. i. p. 208.

the art of gold-beating was so well understood at Rome, that an ounce of that metal could be spread into seven hundred and fifty leaves, each of four inches square.* The account given by Pliny cannot, indeed, be relied upon for strict accuracy, but we know that it was beaten so thin that Lucretius compares it to a spider's web :—

Principio hoc dico, rerum simulacra vagari
Multa modis multis in cunctas undique partes
Tenuia, quæ facile inter se junguntur in auris
Obira cum veniunt, ut aranea, bracteaque auri.

Lucretius, B. 4. *v.* 728.

First, then, observe, from all things round, escapes
A numerous train of subtle, wand'ring shapes;
Meeting in air, they freely blend and twine,
Like filaments of gold, on spider's floating line.

Busby.

It is, however, somewhat singular that, notwithstanding the frequent mention of leaf-gold in the writings of the ancients, there is no account of the instruments and apparatus used in forming it. But the German Monk Theophilus, who is by some supposed to have

* Plin., lib. xxxiii. ch. 3.

lived in the ninth, and by others in the twelfth, century, describes the process used in his time nearly as it is still practised; except that, he does not mention the flatting-mills which are now employed to reduce the ingots into plates; and that, the workmen covered the parchment, between which the gold was beat, with burnt ochre reduced to powder, to prevent its adhering to the cover, while modern gold-beaters make use of fine bolus.

During the progress of this art, it was discovered that common parchment was too thick, and the skin of unborn calves was substituted for that of sheep. By means of this improvement, gold-leaf was beat far thinner than before; but it was only brought to its present perfection by employing that fine pellicle which is detached from the guts of oxen, and which is known, in its prepared state, under the name of *gold-beater's skin*. This discovery was made in the beginning of the last century; but was so long kept secret, that, even in England and Ireland, where it is better understood than on the Continent, it was, fifty years ago, only known

to a few persons. It is a curious fact connected with this substance, that, in the beginning of the revolutionary war, the French entertained the idea of out-manœuvring the armies of their opponents by means of ærostatic machines; and, with that view, the Government circulated instructions for the preparation of this species of skin, which they call *baudruche*. As the process is curious in itself, and so minutely detailed in the instruction to which we have alluded, that some new information may perhaps be collected by those who are interested in the subject, we insert the document at full length:—

"On entend par la peau de baudruche une pellicule mince qui envelope le plus gros boyau du bœuf ou de la vache. Ce boyau est au milieu de la partie que l'on nomme fraise; il est long d'environ deux pieds et demi, placé au bout du boyau gras, et le seul sur lequel on puisse enlever la pellicule nominée Baudruche.

"Cette désignation est suffisante pour la faire distinguer, malgré la différence des noms qu'on lui donne. A Paris l'on appelle *Ratti* la partie du corps de l'animal où se trouve le boyau; ailleurs il se nomme *gros*. Le boyau lui-même porte différens noms, mais il est plus généralement connu sous celui de *Baudruche*.

"Voici la manière d'opérer: en tirant les entrailles du corps de l'animal, on partage la fraise d'avec la panse. C'est dans la première que se trouve la Baudruche. Il faut la détacher de la graisse avec beaucoup de précaution pour ne point l'écorcher ou la percer. On coupe ce gros boyau de la longueur de deux pieds et demi environ, à partir de l'extrémité de la poche qui forme le gros bout. Cette section se fait près d'un petit boyau qui traverse et qui partage ce qu'on appelle le boyau gras, ou gras boyau; on fend ensuite légèrement, et dans toute sa longueur, du côté qui tenoit à la fraise, la pellicule mince qui envéloppe le boyau nommé Baudruche, et d'où elle a pris elle-même le nom de peau de Baudruche; on la lève adroitement sans la déchirer. L'extraction finie, on la lève dans l'eau de rivière ou de pluie; on a remarqué que l'eau de puits altéroit beaucoup les peaux de Baudruches, ce nettoyage enlève les ordures qui auroient pû s'y attacher; il est essentiel de veiller à ce qu'elles ne soient pas traînées dans le sang, attendu qu'elles sont d'un naturel spongieux qui ôte la possibilité de les bien nettoyer lorsque une fois elles en sont imprégnées, elles sont dans cet état longues d'environ deux pieds et demi, et larges de huit pouces. Cette bande est extrêmement mince et transparente. Quand elle est bien lavée on la laisse se réunir dans sa largeur seulement, en lui conservant toute sa longueur. On la fait glisser doucement entre les doigts pour en exprimer l'eau; elle présente alors la forme d'un cordon plus gros qu'un tuyeau de plume; après cette préparation on doit la sécher.

"On suspend les peaux de Baudruches par leur extrêmité autour d'une ficelle, afin qu'elles ne touchent à rien, et que l'air puisse circuler librement autour. On les place dans un lieu sec et à l'ombre, à trois ou quatre pouces de distance les unes des autres.

"Lorsque le dessèchement est opéré, elles n'ont plus que la grosseur d'une paille de froment, et c'est alors qu'elles peuvent être employées."

When these skins have been worn out under the hammer of the gold-beater, they are commonly employed as adhesive plasters; and, notwithstanding the recentness of the modern discovery of the method of preparing them, it is certain that a similar substance was employed for the same purpose so far back as the middle of the twelfth century. This is proved by an anecdote in the life of the Greek Emperor John Comnenus; who, having wounded himself in the hand with a poisoned arrow, had the blood stanched by the application of a thin skin, which, from the description, must have closely resembled that in question.

Of late years, however, the use of gold-beater's skin, for surgical purposes, has been superseded by that of *court-plaster*, which is a composition of thin silk covered with isinglass and Peruvian balsam.

Early in the seventeenth century great astonishment was excited by the promulgation of the fact, that the Parisian gold-beaters

could produce one thousand six hundred leaves, which together covered an area of one hundred and five square feet, from a single ounce of gold. But soon after the fine skin came into use, it was found that the same quantity could be extended so as to cover a surface of nearly one hundred and forty-seven square feet.

The art of gilding, especially unmetallic bodies, was greatly facilitated by the invention of oil painting; but it must be admitted that the process used by the ancients, in what is termed *cold gilding*, was nearly similar to that used at present. Pliny tells us, that the gold-leaf was applied to marble with a varnish, and to wood with a species of cement which he terms *leucophoron;* and that to metals it was affixed by means of quicksilver with the assistance of heat.* The metal was first prepared with salts, and rubbed with pumice-stone, and then heated; and this process is similar to that at present in use for gilding with amalgam, except that Pliny says nothing of evaporating the

* Plin., lib. xxxiii. ch. 20 et 32.; lib. xxxv. ch. 17.

quicksilver by fire after the gold was laid on. That the art was anciently carried to great perfection is, indeed, proved by many existing remains. Among the ruins of some apartments of the Imperial palace on the Palatine hill, at Rome, there were discovered two rooms, on the walls of which the gilt ornaments were as fresh as if they had been newly applied; gilt statues have been also occasionally dug up in perfect preservation, although they must have lain many centuries in the earth; and some gilding is still preserved in the ruins of Persepolis.

False gilding, that is, the art of applying thin leaves of silver, or of tin, to the substance to be gilded, and then rubbing them over with a yellow transparent colour, through which the metallic splendor appears, is very old; and a method of affixing a white metal to paper, and then covering it with a gold varnish, has been known in China from the earliest age of which there is any authentic record. It appears also to have been employed at a very remote period for gilding leather; of which many specimens may be found in ancient leathern tapestry.

Anderson says, in his History of Commerce, that it was introduced into England in 1633, but it seems to have been first attempted either at Messina or at Lucca, and to have been for a long time confined to Italy. But gilt leather was known so early as the time of Lucian, who conjectures that it was made use of by the impostor Alexander, whose thigh appeared to be of gold: "ὁ μηρος αυτου χρυσους δίε φανη, δερματος, ως εικος, επίχρυσου περίτίθεντος;" and Plutarch says that it was worn by the priests of Bacchus, during the celebration of his festival.

GLASS.

DISCOVERY OF GLASS;—MANUFACTURE IN TYRE, AND IN ROME;—GLASS-WINDOWS;—ANCIENT MANUFACTURE OF GLASS IN BRITAIN;—GLASS-ADDERS;—PROGRESS OF THE ART OF MAKING GLASS IN ENGLAND.

THE origin of the art of making glass, like that of many other valuable inventions, is probably due to chance. Pliny relates that it was first accidentally discovered, in Syria, by some travellers while dressing their food at the mouth of the river Belus. Being obliged to make a fire on the ground, where there was a great quantity of the herb kali, that plant burning to ashes, its salts incorporated with the sand, and thus became vitrified. The accident becoming known, the inhabitants of the neighbouring city of Sidon availed themselves of it, and soon brought the art into use. However the correctness

of Pliny's account of the discovery may be questioned, it is certain that the most ancient glass-houses with which we are acquainted were erected in Tyre, which was for many ages the staple of that manufacture; and as it is scarcely possible to excite an intense fire, such as is frequently necessary in metallurgic operations, without vitrifying some part of the bricks or stones of which the furnace is composed, we may easily conceive how the hint of making glass may have been thus accidentally furnished.

The information to be collected from the writings of the ancients respecting the manufacture of glass, is extremely scanty. It is not supposed to have been made in Rome before the reign of Tiberius; at which period we are assured, by various authors, that an artist discovered the means of rendering it flexible; and, it is added, that he was put to death for his invention. Various utensils of glass have been found among the ruins of Herculaneum, which was destroyed in the first century of the Christian æra; but these were no doubt imported from the East; and although it has been conjectured, from the

circumstance of a plate of glass having been found there, that glass windows were at that time in use, yet the first positive mention of them does not occur until more than two hundred years later.

It appears, however, that the art of making glass was understood in Britain before the Roman invasion; for thick rings of glass were at that period found in the island. They were denominated by the natives glass adders, and it is not improbable that they were distributed by the Druids as amulets. Some of these are still occasionally found in various parts of the country; they are of different colours, and a few of them curiously streaked, and we have the authority of history that domestic utensils were formed of the same metal.

We are told by the Venerable Bede, that artificers, skilled in making glass for windows, were first brought into this country from the continent in 674, and were employed in glazing the church of the monastery at Wearmouth. But the art was not generally practised, and the luxury of such windows was slowly adopted, for it was not

until a century after the Norman conquest that they began to be used in private houses, and even then they were considered as marks of great magnificence.

The manufacture of glass was not commenced in England until the middle of the sixteenth century, at which time the chief works were in Crutched Friars; but the finer sort of flint glass was first made at the Savoy house, in the Strand. Considerable improvements were made about the year 1635, when a patent was granted to Sir Robert Mansell, who also possessed a monopoly of the importation of Venetian drinking-glasses, the art of making which was not brought to perfection, in this country, until the reign of William III. The first plate-glass was made in 1673, at Lambeth, and this manufacture was introduced by the Duke of Buckingham, who for that purpose brought over several Venetian workmen. From this period the manufacture of plate-glass, in this country and other parts of Europe, has received various improvements, a succinct account of which will be found under the head of MIRRORS.

GLASS-CUTTING.

ANTIQUITY OF THE ART OF GLASS-CUTTING;—DIAMOND DUST;—DIAMOND PENCILS;—ANECDOTE OF FRANCIS I.;—INVENTION OF THE ART OF ETCHING ON GLASS.

It is generally supposed that the art of glass-cutting was invented by one Caspar Lehmann, who, in the year 1609, was in the service of the Emperor Rhodolphus II. as a lapidary. It is, however, sufficiently proved, by various articles still preserved in collections of antiquities, that the Greek artists formed upon glass both raised and engraved figures; and, although it is probable that pieces of glass may have been moulded like paste, for that is an art that was very anciently understood, it is yet certain that they cut all kinds of ornaments on glass with

considerable accuracy in the modern manner. The learned Natter, indeed, affirms, in his treatise on engraved stones, that the ancients even employed the same instruments as the moderns; and it certainly does appear that they used a wheel which moved in a horizontal direction above the work-table, and seems to have been in most respects similar to the common lapidary's wheel.

Although it is also certain that the ancients employed diamond dust for the purpose of polishing various kinds of precious stones, it yet does not appear that they were acquainted with the mode of cutting glass with a diamond pencil. The oldest glaziers with whose manner of working we are acquainted used emery, with sharp-pointed instruments of steel, and a red-hot iron, by means of which they gave the necessary direction to the rents.

The first mention that is made of a diamond being employed for writing on glass, occurs in the history of Francis I. of France, who inscribed the following lines on a window at the castle of Chambord, near Blois,

in order, as it is said, to intimate to the Duchess of Estampes that he was jealous:—

> "Souvent femme varie
> Mal-habil qui s'y fie."*

It has also been generally imagined, that the art of etching on glass, which is effected by an acid that dissolves silicious earth, was first invented in 1771, by a German chemist named Scheele; but it can be proved that it was discovered so early as 1670 by an artist named Schwanhard, who was celebrated as a glass-cutter, and by the mere accident of some aquafortis having fallen on his spectacles and corroded them.

At present the glass is spread with varnish, and the figures to be etched on it are traced through it; but Schwanhard first sketched the figures, then covered them with varnish, and corroded the glass around them with the liquid, by which means a bright smooth figure was produced upon a dim ground.

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* The pane of glass with the above inscription is still preserved at Chambord; but the anecdote has been usually attributed to Henri IV. The château is now the property of the infant Duke of Bordeaux, for whom it was lately purchased by a national subscription.

HYDROMETER.

OPERATION OF THE HYDROMETER;—ORIGINAL INVENTION;—SYNESIUS AND HYPATIA;—DESCRIPTION OF THE ANCIENT HYDROMETER;—REVIVAL OF THE INVENTION.

The hydrometer is an instrument which serves to determine the specific gravity of different fluids by the depth to which it sinks in them. The laws by which that comparative gravity is governed were discovered by Archimedes, on trying an experiment to ascertain the content of a golden crown made for Hiero, king of Sicily; and it has been thought not improbable, that he, at the same time, invented the instrument in question. As he died two hundred and twelve years prior to the Christian æra, this would carry the invention back to a very remote period;

but it is not alluded to by authors of a much later date, and the first mention of it occurs in the letters of Synesius to Hypatia, in the beginning of the fifth century. The character and singular fate of these two persons—but little known to history—is sufficiently interesting to merit attention, and will, doubtless, excuse a brief digression.

Hypatia was the daughter of Theon, a celebrated mathematician of Alexandria, some of whose works are still extant. At an early age she acquired, from her father, a knowledge of the sciences, and, from other learned men, such an intimate acquaintance with the platonic and Aristotelian philosophy, that she taught them publicly with the highest applause. Young, beautiful, and accomplished, she was surrounded by admirers; but her devotion to the cause of learning precluded the indulgence of a softer passion, and she resisted every solicitation to become a wife.

At this time Alexandria was a prey to civil discord. The Patriarch of the Christian Church, Cyril, a man of an arrogant and vindictive spirit, and intolerant principles,

blind to every consideration but what he deemed the interest of his faith, insisted on the expulsion of the Jews, to whom the city was indebted for much of its commerce, and consequent opulence. The measure was therefore opposed, upon every ground of policy as well as humanity, by the governor of the place; and he even punished, capitally, a Christian who was convicted of some crime against a Jew. Cyril took advantage of the circumstance to inflame the passions of his partisans; and, aided by the Monks, excited an insurrection among the Christian populace, who plundered the Jews, and expelled them from a city which had been the residence of their forefathers from the time of Alexander the Great.

Hypatia had not renounced the errors of paganism, and whether this alone, added to her justly great reputation, had inflamed the jealousy of the turbulent churchman, or that some imprudent remark on the recent events had stimulated his resentment, does not appear; but certain it is, that as he had incited the religious rage of the people against the unfortunate Jews, he in like

manner instigated them to attack the innocent Hypatia. An infuriate mob seized the unoffending object of their fanaticism in the street, hurried her to the church,, where they stripped off her clothes, tore her flesh to pieces with pincers, then dragged her mangled limbs about the city, and at length burned them.

Among the most ardent of the admirers of Hypatia was Synesius; himself of a noble pagan family, a philosopher, and a mathematician. His learning, talents, and disposition, had gained him universal esteem; and such was the purity of his morals, that, notwithstanding his pagan creed, the Christian Church of Ptolemais desired to have him for their Bishop. Synesius listened to the proposal with reluctance, and at length only consented to accept of the office, on condition, *that he should not be required to subscribe to the doctrine of the resurrection of the dead!* Incredible as it may now appear, his terms were acceded to, and he was actually baptized, and installed, with that reservation; though he afterwards admitted the tenet of futurity. He died in

431, sixteen years after the tragedy we have recorded. His writings have been preserved; and among his correspondence with Hypatia, is the following description of the Hydrometer, or, as it was then termed, the *Hydroscopium*.

"It is a cylindrical tube, of the size of a reed; a line drawn upon it lengthways, is intersected by others, by which we learn the weight of the water. At one end of the tube there is a cone, the base of which is joined to that of the tube; and this part of the instrument is called the *baryllium*. When immersed in the water, the tube remains in a perpendicular position, so that the cross-lines can be counted, and by them the weight is ascertained." This is evidently an Hydrometer of the most simple construction: the cone, at the lower extremity, without being sufficiently heavy to entirely sink the tube, serves to keep it erect; the lighter the fluid is in which it is placed, the further it will descend; and the difference of gravity between any two liquids will be discovered by the scale of lines. Its correctness may be proved by filling a vessel alternately with an

equal weight of different fluids, in which case the lighter will occupy more space than the heavier: thus, if twenty-one divisions of the instrument be covered in water, and twenty-four in oil, it will be found, that only twenty-one parts of oil can be contained in the same space occupied by twenty-four of water.

The knowledge of the hydrometer appears to have been lost during the middle ages, and not to have been revived until towards the close of the sixteenth century, when it was regarded as an entirely new invention. Various subsequent improvements have been made on it; and, by an ingenious graduation of the scale, founded on repeated experiments, it is now generally used to ascertain the strength of ardent spirits.

LINEN MANUFACTURE.

FLAX;—ANTIQUITY OF LINEN;—TABERNACLE OF THE JEWS; — EGYPTIAN MUMMIES; — INTRODUCTION OF LINEN INTO EUROPE;—PROGRESS OF THE MANUFACTURE;—ADOPTION OF LINEN IN DRESS;—MANUFACTURE IN ENGLAND, AND IN IRELAND.

FLAX was originally indigenous in the Levant, and it was long before it was introduced into Europe. While cotton was manufactured into cloth in the East-Indies, it is supposed that linen was equally common in Egypt. It is frequently mentioned in the old Testament, and particularly in the books of Moses, the most ancient of the Scriptural writers. Thus we read in the directions for the construction of the Tabernacle:—" Moreover, thou shalt make the Tabernacle with ten curtains of fine twined linen, and blue, and purple, and scarlet: with cherubims of

cunning work shalt thou make them.* This, however, as the original Hebrew does not specify the substance of which the cloth called in the version, linen, was formed, would be only slight evidence of the manufacture of *Flaxen* cloth in Egypt at that period, were it not from thence that it was first obtained, and thence only that Europe was for a long time supplied with it. Mummies are also generally found swathed in linen; and, as the art of preserving bodies in that manner was practised in Egypt in the remotest ages, there can be no doubt that linen was made there at an æra of very great antiquity.

The ancient Greeks were unacquainted with the use of linen, and it was not until the second century of the Christian æra that it was introduced into Rome. Before that period the tunic or under garment of the Romans was made of wool, and the Emperor Alexander Severus is said to have been the first European who wore a linen shirt. But this luxury was then so ill understood, that the web was usually interwoven with threads of gold, by

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* Exodus, ch. xxvi., v. 1.

which the softness of its texture was entirely destroyed.

The manufacture of linen made but little progress in Europe during the middle ages. It was confined, both then and for a long period afterwards, to private families, where the thread was spun and the web was wove for domestic use; and its scarcity, as an article of apparel, has been considered as one chief cause of that cutaneous disorder formerly known under the name of leprosy. There is a letter extant, from St. Boniface to a German Bishop, written in the eighth century, in which he mentions having sent some napkins to him, as a great rarity. La Flamma, a writer of the fourteenth century, says that, in the time of Frederic Barbarossa, linen was so little known, that shirts of serge were generally worn in Milan; and, about the same period, flannel, or rather that coarse stuff, vulgarly termed linsey-wolsey, formed the usual underclothing of ladies. Linen seems indeed to have been earlier adopted as a luxury for the table than the person, and we read of its being used at banquets long before it was known as an article of dress.

It has been supposed that the linen manufacture was introduced into this country by the Romans; but of that there is no proof. It is, indeed, probable, that, like other arts with which the Romans were acquainted, it may have been partially known; but no vestiges of it have been discovered, and if it really was practised at that period, it was afterwards lost, and only slowly recovered; for although it is true that linen was in use in England many centuries ago, yet it was then imported from Flanders.

The chief linen manufacture of the British dominions has been long established in the North of Ireland, where it is carried on to an extent that renders it one of the most valuable staples of the united kingdom. The importance of the trade may be estimated from the fact, that more than 40,000,000 yards of linen cloth are, upon an average, annually exported from Ireland; and its progressive increase has been so rapid, that it is now ten times greater than it was in the middle of the last century.

MIRRORS.

ANTIQUITY OF MIRRORS;—BRAZEN LAVER OF THE TABERNACLE;—ANCIENT MIRRORS OF SILVER AND OF MIXED METAL; — OBSIDIAN STONE; — PHENGITES; — MIRRORS OF THE PERUVIANS; — TYRIAN GLASS-HOUSES;— INVENTION OF GLASS MIRRORS;—VENETIAN LOOKING GLASSES; — FRENCH GLASS-HOUSES; — MANUFACTORY OF ST. ILDEFONSO;—BRITISH PLATE GLASS MANUFACTORY.—CONCAVE MIRRORS.

A LUCID stream was doubtless the first mean through which the charms of the shepherdesses of the golden age were reflected; but there is reason to believe that artificial mirrors were made, almost as soon as the ingenuity of man was exerted on mechanical objects, and as every solid body capable of receiving a fine polish would suit this purpose, we find that the oldest mirrors mentioned in history were of metal. Thus

Moses relates that the brazen laver of the Tabernacle was made from the mirrors of the women, and similar allusions are to be found in other parts of the Old Testament.* It is, indeed, true, that in the common English version of the Scriptures, the word "*looking-glass*" is employed instead of *mirror;* but this is one of the numerous verbal inaccuracies in that translation, in the original of which the term is not to be found.

Some commentators on the writings of the ancients have conjectured that mirrors were not known in the time of Homer, because he does not mention them in the description which he gives in the Iliad† of the toilet of Juno, and the objection must undoubtedly be admitted to possess considerable weight; but on the other hand it has been observed, that the ancient mythologists did not consider it becoming in either Juno or Pallas

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* "*Old Testament.*" And he made the laver of *brass*, and the foot of it of *brass*, of the *looking-glasses* of the women assembling, which assembled at the door of the Tabernacle of the congregation. *Exod.* ch. xxxviii. v. 8.

† "*Iliad.*" lib. xiv. v. 166.

to have recourse to an instrument of mere mortal vanity: though, in opposition to this argument we find, that Apuleius, in his *Floralia*, enumerates mirrors among the valuables belonging to Juno in the island of Samos. Others have ascribed the invention of mirrors to Æsculapius, and Cicero has been quoted as authority for the supposition, but it would appear from the passage in his writings that he alluded to the more probable instrument, a probe.*

The greater number of the ancient mirrors were made of silver; not so much, however, with a view to magnificence, as because silver is the fittest of the unmixed metals for that purpose. When silver plate is mentioned in the Roman laws, in allusion to heirships, mirrors of this description are rarely omitted, and the satirists of the latter ages of the republic describe them as being so common, that no young woman was without one. At first, only the finest silver was employed; but it was afterwards used of an

* "*Probe.*" Æsculapiorum primus qui *specillum* invenisse et primus vulnus obligasse dicitur. *De Nat. Deor.* iii. 22.

inferior quality, and, what must now appear singular, the presence of the alloy was discovered by the smell. Pliny tells us that Praxiteles invented silver mirrors in the time of Pompey the Great; but, unless he merely alluded to their introduction among the Romans, the correctness of his assertion is disproved by a passage in Plautus,* from which it appears that they were in use at a much earlier period in Greece. They were often so large as to reflect the entire figure, and were formed of thin plates or of coarser metal silvered over. Mirrors were also formed of a mixture of copper and tin, and the bset, as Pliny informs us, were made at Brundusium. This mixture produces a white metal that is proper for the purpose; but unless preserved with great care, it is apt to grow dim, and on this account a sponge and pounded pumice-stone were usual appendages to the ancient mirrors. Some of them are still preserved in collections of antiquities; and from chemical experiments made by

* *Plautus.* Mostell, act i. sc. 3.

Count Caylus,* on one that was found near Naples, it would appear that regulus of antimony also entered into their composition; but this was no doubt of comparatively modern date, for that substance was not known to the ancients.

Mention is also made in various ancient authors of mirrors formed of obsidian stone, or, as it is now commonly termed, Icelandic agate; but they seem to have been rather for ornament than use, and were chiefly employed for pannels in the walls of splendid apartments. We also learn that Domitian caused a gallery in which he used to walk to be lined with a substance termed *phengites*, which reflected whatever passed before it, and which probably was a calcareous or gypseous spar, or selenite. The black marble of Chio was also used for a similar purpose.

It is a curious fact, that mirrors, both plane, convex, and concave, were found among the Peruvians on the first discovery of America. Some of them were made of

* "*Caylus.*" Recueil d'Antiquités, tom. v. p. 174.

a black, vitrified lava, called by the Spaniards *gallinazo*, which is similar to the obsidian stone of the Romans. They had others also of a fossil which they termed the Inca's stone, which was a compact pyrites or marcasite, susceptible of a very high polish. One of these was a foot and a half in diameter, but in general they did not exceed two or three inches. It appears even that the Americans were in possession of mirrors of silver, copper, and brass.

The date of the invention of glass mirrors has long been a subject of discussion among antiquaries. The authority of Pliny has been adduced to prove that they were formed in the ancient glass-houses of Tyre, and his language is so clear, that no doubt can be entertained of some attempts of the kind having been made.* It is, however, far from certain that those experiments were successful; for Pliny would scarcely have omitted

* Aliud vitrum flatu figuratur, aliud torno teritur, aliud argenti modo cœlatur, sidone quondam iis officinis nobili siquidem etiam specula excogitaverat. Hæc fuit antiqua ratio vitri. *Plin. Hist. Nat.*, lib, xxxvi. cap. 26.

to speak more particularly of so important a discovery, if it had been completed, nor could it have failed to have superseded the less useful employment of metal for the same purpose. Besides, although glass was held in the highest estimation at Rome, and although it is often mentioned by ancient writers among the most costly pieces of household furniture, yet mirrors are only alluded to among articles of plate.

It is probable that the first glass mirrors were made of some dark coloured glass resembling the obsidian stone, and that a long time elapsed ere the idea occurred of covering the back part with some opaque substance. It has, indeed, been conjectured by Dr. Watson, and others, that this discovery must have been made at an early period—because it was so apparent; but the supposition rests upon no stronger foundation. It has not been alluded to by Alhazen, the Arabian, who, in the eleventh century, wrote a treatise on optics; nor by the Italian Vitello, who treated of the same subject near two centuries later; and there is no positive evidence of its having been known sooner than

about the year 1279. At that time an English Franciscan monk, named John Peckham, wrote a work on optics, which has been since printed, in which he not only speaks of glass mirrors, but also mentions that they were covered on the back with lead. We may, indeed, conclude that this invention cannot be much older, from the circumstance that glass mirrors were scarce in France even in the fourteenth century, while mirrors of metal continued in common use; and we are expressly told that Anne de Bretagne, wife of Louis XII., used one of the latter description.

Of the progress of the art little more is known except that, at first, melted lead was poured over the glass plate while yet hot as it came out of the furnace, and that afterwards an amalgam of tin was applied. The method which approaches the nearest to that still in use, seems to have been first practised in the sixteenth century at Murano, in the Venetian territory, the glass works at which place for a long time furnished all Europe with the largest and finest mirrors. Tin foil was spread out smoothly, and rubbed

over with quicksilver, and, when the tin was saturated, it was covered with paper. The glass was then laid upon it, and while the workman pressed it firmly down with one hand, he, with the other, carefully drew out the paper which lay between the tin and the glass, over which a heavy weight was afterwards laid in order to make them adhere.

The first attempts to establish a manufactory of mirrors in France, were made towards the middle of the sixteenth century. One Eustache Grandmont first obtained a patent for that purpose in the year 1634, but his undertaking failed; and it was not until 1665 that the project, being patronized by Colbert, was attended with success. At that period Nicholas de Noyer obtained an advance from the Crown of twelve thousand livres for four years, to assist him in establishing a manufactory after the Venetian method. With this slight assistance, he, in conjunction with one Poquelin, who had been a large dealer in Venetian glass, erected the first works for that purpose at the village

of Tourlaville, near Cherbourg. The largest plates that were there made did not exceed fifty inches in length: but, in 1693, one Thevart obtained another patent for casting plates of larger dimensions, and he succeeded so far as to form them eighty-four inches in height by fifty in breadth. This manufactory was established at the palace of St. Gobin, in Picardy, and the interests of the patentees were afterwards joined with those of the proprietors of the original works at Tourlaville, at both which places mirrors of great size and beauty are still made. They were, however, excelled, in point of size at least, by those made at the celebrated manufactory at St. Ildefonso, belonging to the Crown of Spain, where the largest mirrors ever constructed continued to be made until the irruption of the French into that country, during the late war, and the events that followed put a stop to the works.

In this country an extensive manufactory of what is commonly called plate-glass, that is, glass which is cast instead of blown, was first established in Lancashire in 1773, and

was incorporated by Act of Parliament. It has not, however, been attended with any extraordinary degree of success; and, although mirrors of very large dimensions are there made, they are not considered equal in brilliancy and richness to those of either France or Spain.

In one delicate and most difficult branch of the art, however, the English manufacturers excel all others, for they have succeeded in making concave mirrors of a size and accuracy unknown on the continent.

MUSICAL-NOTE MACHINE.

ORIGINAL INVENTION;—FREKE;—UNGER;—HOHLFELDT;—DR. BURNEY'S MUSICAL TOUR.

It is somewhat singular, that two persons, one an Englishman—Mr. John Freke—and the other a German, of the name of Unger, should have simultaneously conceived the idea of constructing a machine "that shall write extempore voluntaries, or other pieces of music, as fast as any master shall be able to play them upon an organ, harpsichord, &c."

The words here quoted are taken from the Philosophical Transactions for the year 1747, but they are not accompanied with instructions for making the instrument. That honor was reserved for Hohlfeldt, who is mentioned in the article *Odometer*, and who succeeded in forming the machine in question, a com-

plete description of which is inserted in the "*Mémoires de l'Académie de Berlin*, 1771."

In Dr. Burney's Musical Tour, it is mentioned as an English invention, in consequence of the article in the Philosophical Transactions already alluded to; but that only conveyed the idea; the execution undoubtedly belongs to Hohlfeldt, assisted perhaps by the more detailed description given by Unger, in his communication to the Berlin Academy in 1752.

ODOMETER.

ANTIQUITY OF THE ODOMETER;—ITS APPLICATION;—AND PERFORMANCE;—ANCIENT ODOMETER AT DRESDEN;—ENGLISH INVENTION;—PEDOMETER;—MERLIN'S CARRIAGE.

THE instrument known as the Odometer, by which the revolutions of the wheels of a carriage may be ascertained, is supposed to have been known to the Romans. Vitruvius describes a machine of this kind; and the Emperor Commodus is said to have possessed carriages, with various wheels, which measured the road, and even indicated the hours.

That it was known in the fifteenth century, appears from a carving on the front of the ducal palace at Urbino, erected in 1482; but it is there applied to a ship. At a period not greatly subsequent, in 1550, a degree of the equator was measured with it, between

Amiens and Paris: it was affixed to a carriage, the wheels of which made one hundred and seventy thousand and twenty-four circumvolutions, which were each marked, as we are told, by the striking of a hammer on a bell. These, being reduced into feet, were found to amount to fifty-six thousand seven hundred and forty-seven toises, which is within three hundred of what it has been found by later measurement.

In the collection of curiosities at Dresden, is an Odometer, which the Elector of Saxony employed, from the year 1553 to 1586, in measuring his territories: and the Emperor Rodolphus, who reigned from 1576 to 1612, possessed two of these instruments, which not only measured distances, but marked them, at the same time, on paper.

Towards the close of the seventeenth century, an English artist, named Butterfield, invented an odometer; and from that period, various foreigners improved upon the machine, until, in the middle of the last century, an ingenious German mechanic, of the name of Hohlfeldt, appears to have invented the pocket pedometer, by means of which the

number of steps which a person takes, while walking, may be counted. In our own times, many persons must recollect the equipage of the celebrated Merlin, which was continually to be seen in the streets of London, with an odometer so constructed as to mark the revolutions of the wheels on an index placed in front of the carriage.

These machines are now in common use for measuring distances in land-surveying, but are rarely applied to carriages.

ORRERY.

PLANETARINA; — GRAND ORRERY; — LORD ORRERY;— GRAHAM'S ORRERY;—ROWLEY'S ORRERY;—FERGUSON'S ORRERY;—PRIESTLEY'S ORRERY;—REV. DR. PIERSON'S ORRERY AND PLANETARY MACHINES;—BUSBY'S SELF-ACTING HYDRAULIC ORRERY;—WALKER'S ORRERY.

THE Orrery is a machine made use of to shew the positions and motions of the heavenly bodies, *i.e.* the planets and their respective satellites. The orrery differs from the instrument termed a "planetarium," inasmuch as it shews the rotatory, or *diurnal* motions of the primaries, and the satellites moving about them in their particular orbits, whereas the "planetarium" merely shews the *annual* motions of the primaries themselves. But to constitute an "orrery," it is not necessary that all the planets should be included. A machine repre-

senting the motions of the sun, the earth and the moon alone, would still be called an "orrery," whereas if the whole system were included, it would be termed "The Grand Orrery."

This machine derives its name from the circumstance of an apparatus of this description having been made for the Earl of Orrery by a person named Rowley, shortly after the year 1715.

In searching for the history of this interesting machine, it will be found that in the year 1715, an instrument of this kind was made by Mr. George Graham, but confined to the representation of the motions of the sun, earth, and moon; being forwarded through the hands of some workmen to Prince Eugene, it fell, in some way or other, under the observation of Rowley, who immediately conceived and executed the idea of producing a prototype, under the patronage of Lord Orrery. Sir Richard Steele, ignorant of the origin of Rowley's instrument, named it the "Orrery," in compliment to the nobleman who bore that designation.

To enter into the minutiæ of these instru-

ments would be foreign to the plan upon which this work is undertaken; suffice it therefore to say, that, it is admitted on all hands that Rowley improved upon Graham, and extended his apparatus to all the superior planets then know. A superb Orrery was subsequently made under his direction by T. Wright, mathematical-instrument maker to George the Second, in the year 1733, and is still preserved at Richmond Observatory.

The celebrated James Ferguson next invented and constructed several instruments for illustrating astronomical phenomena; his principal work comprized the Sun, Mercury, Venus, the Earth, and the Moon; and is described in his book entitled "Select Mechanical Exercises."

Next in order comes the "Orrery" of James Priestley, Esq., of Bradford, in the county of York. This gentleman was a relative of the famous Dr. Priestley, his orrery was made for Dr. Birbeck, the successor of Dr. Garnett, professor at the University of Glasgow. A considerable degree of perfection was attained by Mr. Priestley; and his Orrery included the orbit of Saturn.

But the person who has carried these mechanical contrivances to the greatest perfection, is the Rev. Dr. Pearson. This gentleman has not only constructed the "Grand Orrery," on a principle of mechanical accuracy heretofore deemed unattainable, but has expended a sum of *ten thousand pounds* in producing a variety of the most elaborate planetary machines, constructed on such unerring principles as to enable him practically to ascertain, without the aid of calculation, the series of eclipses of the sun and moon, and of Jupiter's satellites; the transits of the inferior planets; the occultation of the fixed stars, for many succeeding ages. These are minutely described in Dr. Rees's Cyclopædia, to which work we must beg to refer our readers for the particulars.

Last in order of time comes the self-acting Hydraulic Orrery, recently invented and constructed by Mr. Busby, on a principle entirely different from any that has yet been devised. The effect of the various spontaneous motions is truly magical; the machine displays with the most impressive silence, and with the most harmonious movements, the circuits,

obliquities, parallelisms, and rotations of the sun, the earth, and the moon, on an area five feet in diameter, while the unruffled surface of the fluid beneath reflects the system, and doubles the illusion. Mr. Busby has also constructed a floating machine, by means of which he illustrates the motions of Jupiter and his satellites in a most interesting manner. He has besides arranged a more extensive plan for the "Grand Orrery," and intends to display the whole planetary system on hydraulic principles. Mr. Busby's present Hydraulic Orrery is publicly exhibited.

We cannot conclude this article without alluding to the well-known Transparent Orreries of Walker and others. These, however, are merely calculated for scenic representation, and their mechanism does not extend to the oblique motions, upon which some of the most important astrononomical phenomena necessarily depends. But it must be admitted, on all hands, that they have been of the greatest use in directing the public attention to astronomical objects; and in promoting the cause of science in her most extended operations.

RIBBON-LOOM.

DESCRIPTION; — MANUFACTORY IN THE MILANESE; — INVENTION;—DANTZIC RIBBON-LOOM;—SINGULAR PREJUDICE;—DUTCH LOOM-ENGINE;—ESTABLISHMENT IN ENGLAND.

In the general construction of its parts, this loom bears a strong resemblance to the common weaving-loom; but it has this one material advantage, that while the workman at a common loom can only weave one piece, he can, with this machine, make as many as twenty at one time, and these even of different patterns. It is so formed as that the weaver can move the batton both towards and from him, and also to the right and left, with all its shuttles; and it is furnished with machinery below, which can be moved by a person unacquainted with the art of weaving, and which keeps the entire loom and shuttles in regular motion. At a ribbon manufactory

in the Milanese, there were, not many years ago, thirty of these looms, the machinery of which was worked by water, each of which could weave twenty-four pieces together; so that, when the whole were employed, they made, at once, sixty dozen pieces.

Of their first invention, there is no certain information: it has been attributed to the Swiss; but the first positive account mentions it as having been invented at Leyden, about the year 1621. There is, however, in the works of the Abbot Lancellotti, published in 1629, a circumstantial narrative of a ribbon-loom, which was invented, at Dantzic, about fifty years before, and which, when set in motion, made from four to six pieces, of itself: ("*da se Stesso;*") but the magistrates of the town, fearing lest by this invention many workmen might be deprived of employment, interdicted its use; and it farther appears, that, not content with this prohibition, they even caused the inventor to be privately strangled!

This prejudice against the introduction of machinery, which is not even at present without its advocates, was formerly so strong, that many ingenious contrivances to lessen

labour were suppressed by governments, as injurious to population, and consequently to the state. The States-General of Holland, in that view, repeatedly circumscribed the use of the ribbon-loom, although they did not altogether abolish it: in the Spanish Netherlands, and throughout the greater part of Germany, it was strictly prohibited; and the council of Hamburgh ordered a loom to be publicly burned. But these coercive measures were unavailing: as some places still remained open to its introduction, the manufacture of ribbons was gradually removed to those cities where the establishment of the new loom was permitted, and became lost to those governments which opposed its adoption. Insomuch, that not only were they at length forced to retract the prohibitions formerly issued against its use, but finally to offer premiums for its employment.

The ribbon-loom was brought to England, from Holland, in 1676, and was then called the Dutch loom-engine. Its introduction occasioned some disturbances among the ribbon-weavers in London, but its evident utility ensured its adoption.

SAW-MILLS.

ANCIENT MODE OF PRODUCING PLANK;—SPLIT-TIMBER; ANTIQUITY OF THE SAW;—INVENTION;—ANCIENT PAINTING AT HERCULANEUM;—INVENTION OF SAW-MILLS;—ESTABLISHMENT IN ENGLAND;—DUTCH AND SWEDISH MILLS;—BRUNEL'S MILL.

At an early period, the trunks of trees were split into planks with wedges, and these were afterwards reduced by the operation of the adze. Before the middle of the sixteenth century, all the plank in Norway was hewn in this manner, and trees, from which seven or eight boards could now be procured, then only produced two. This simple but wasteful mode has not, in some parts of the North, been even yet entirely exploded; and it must be admitted, that it is attended with some advantages which the saw does not possess. The work is more expeditiously performed;

and split timber is far stronger than that which has been sawn; for, the fissure follows the grain of the wood, and leaves it undivided, whereas the saw, by cutting along a specific line, divides the fibres, and thus weakens its cohesion and solidity: besides, as the fibres retain their natural position, they are easier bent, and this is an advantage, in many kinds of work, which more than compensates for the timber being sometimes warped.

The saw is, however, an instrument of the most remote antiquity; and its advantages were so well appreciated by the ancients, that they ranked the inventor among the Gods. The discovery was attributed to the accidental use of the jaw-bone of a snake in cutting through a piece of wood; which is not improbable, as some snakes have teeth of that kind; and in some of the recently discovered Islands in the Pacific Ocean, the natives appear to have made use of the serrated bones of fish for a similar purpose.

The form of the ancient saw has been accurately ascertained through the preservation of a curious relic of antiquity found among the

ruins of Herculaneum. It is a painting, in which are represented two genii, in the act of sawing a piece of timber: the plank is extended on a long bench, to which it is fastened with cramp-irons, and over one end of which it projects; here the workmen are seen, one standing, the other seated on the ground, performing the operation with a frame-saw, which appears, in every respect, similar to that still in use. The blade is fixed in a square frame, the handles of which are formed as at present, and the teeth stand perpendicular to the plane of the frame; the cramps are shaped like the figure 7, which is the form still adopted in some kinds of work; and the bench itself bears a strong resemblance to the modern carpenter's table. In another part of the picture, is a small tablet affixed to the wall, on which is a vase, the use of which must be left to conjecture.

The ingenious improvement of this instrument, by adapting it to mills, was first introduced in Germany, and so early as the year 1322, we find saw-mills established at Augsburgh. From that period they became so general, that, on the settlement of the island

of Madeira, they were erected there by the Portuguese; and Abraham Peritsol, a Jew who wrote in the beginning of the sixteenth century, describes them as having been employed to furnish the city of Lisbon, from the forests of the island, with large quantities of plank of various rare wood, of which was formed the most beautiful furniture. The Bishop of Ely, who was Ambassador from Mary, Queen of England, to the Court of Rome, in 1555, thus describes one which he saw in the neighbourhood of Lyons:—"the saw-mill is driven with an upwright wheel, and the water that maketh it go is gathered into a narrow trough, which delivereth the same water to the wheels. This wheel hath a piece of timber put to the axle-tree end, like the handle of a broch, and fastened to the end of the saw, which, being turned with the force of the water, hoisteth up and down the saw, that it continually eateth in, and the handle of the same is kept in a rigall of wood from swerving. Also, the timber lieth as it were, upon a ladder, which is brought by little and little to the saw with another vice."

This invention, however, does not appear

to have been adopted in England until 1663, when a Dutchman erected one near London; but it was so violently opposed by the sawyers that it was soon abandoned. From this period, no effectual attempts seem to have been made for its introduction, until about the year 1767, when a saw-mill, driven by wind, was erected at Limehouse, under the direction of one Hansfield, who, however, had learned the manner of constructing it in Holland; but this was soon destroyed by a mob; and although it was afterwards re-built, the plan has not, even yet, been generally acted upon. In every other part of the North of Europe, however, and in America, it has long been in activity. Saardam, in Holland, is supposed to possess a greater number of saw-mills than any one other place; but the largest is in Sweden, where one water-wheel, of twelve feet diameter, drives at once seventy-two saws.

But every invention of this kind has been eclipsed by the circular saws in the mills belonging to the ingenious Mr. Brunel, so well known for the contrivance of the admirable apparatus in Portsmouth Dock-Yard

for cutting ships' blocks. These mills are erected at Battersea. The saws are four in number, two of eighteen, and the others of nine feet in diameter: they are, in fact, wheels edged with slender saws which cut through the wood without occasioning much waste; and are turned by a steam engine of sixteen horse power, which, at the same time, draws the timber to them. The larger saws revolve sixty-five times in a minute; therefore, the circumference being equal to a trifle more than three times the diameter, or to fifty-four feet and a fraction, gives a rate of velocity equal to about three thousand seven hundred feet in that space of time. This is supposed to be full forty times greater than that of the average stroke of the common upright sawyer's tool; while the accuracy with which the work is performed by the former, and the saving of the wood, cut into saw-dust by the latter, are decisive of their superiority. Planks of fine wood are thus cut into veneers, for cabinet-work, of the sixteenth part of an inch in thickness, and that with a rapidity and precision that are truly astonishing.

STEAM-ENGINE.

MARQUIS OF WORCESTER'S;—SAVARY'S;—AMONTON'S;—PAPIN'S;—BLAKEY'S;—NEWCOMEN'S;—BEIGHTON'S;—SMEATON'S;—WATT'S;—WALFE'S;—TREVETHIC'S.

THIS grand machine was entirely unknown to the ancients; it is used as a *primum mobile,* or first mood, of other machines, and its powerful effects are the result of the scientific combinations by which the immense expansive force exerted by water, when converted into steam, is rendered available to the most important purposes. In its original imperfect state, it was called the "*Fire-Engine.*"

The power of steam had been proved by the œlipile, long before the project of the steam-engine; for it appears that an Italian philosopher named Brancas, did actually con-

trive the plans of several mills to be worked by the reactive impulse of large œlipiles.

The original projector of the Steam-Engine is generally believed to have been the Marquis of Worcester; but his apparatus was intended to raise water by the expansive force of steam only. A short account of this first steam-engine we extract from a work by the Marquis himself, entitled "A Century of Inventions," (of which it is one), and published as early as 1655.

"68. An admirable and most forcible way to drive up water by fire; not by drawing or sucking it upwards, for that must be as the philosopher calleth it *intra sphœrum activitatis*, which is but at such a distance. But this way hath no bounder, if the vessel be strong enough: for I have taken a piece of whole cannon, whereof the end was burst, and filled it three-quarters full of water, stopping and screwing up the broken end, as also the touch-hole; and making a constant fire under it, within twenty-four hours it burst, and made a great crack; so that having a way to make my vessels, so that they are strengthened by the force within them,

and the one to fill after the other, I have seen the water run like a constant fountain stream, forty feet high: one vessel of water, rarified by fire, driveth up forty of cold water; and a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively; the fire being tended and kept constant, which the self-same person may likewise abundantly perform, in the interim between the necessity of turning the said cocks."

The project of the Marquis of Worcester was neglected in his own age, nor does the subject appear to have excited the attention of scientific persons, till the year 1698, when Captain Savary obtained a patent for a new invention for raising water, and occasioning motion to all sorts of mill-work, by the impellent force of fire. This patent is dated 25th July, in the tenth year of the reign of William the Third—that is, 1628.

Captain Savary produced a working model of his engine before the Royal Society, as appears by the following extract from their Transactions for that year:—

"Mr. Savary, June 14, 1699, entertained the Royal Society with shewing a small model of his engine for raising water by help of fire, which he set to work before them: the experiment succeeded according to expectation, and to their satisfaction."

About the same period M. Amonton, a Frenchman, devised what he called the "fire-wheel," and pretended that Savary had borrowed from him; but the projects of Savary and Amonton were widely different, and time has nearly consigned that of Amonton to merited oblivion.

The next pretender to the improvement of the steam-engine was Dr. Papin, who in 1707 published a tract, containing an account of his invention, entitled "*Ars nova ad aquam ignis adminiculo efficasissime elevandum.*" Belidor, in his "*Architecture Hydraulique,*" has described this engine to be mainly the same as that suggested by the Marquis of Worcester, and by no means comparable with what had already been done by Captain Savary.

In 1766, Mr. Blakey endeavoured to improve upon Savary's engine; he took a patent for his supposed amendments, but never performed any thing worth recording.

Several other ingenious men turned their attention to the improvement of the steam-engine, with a view to reduce the consumption of fuel, which was found to be so immense, as to preclude its use, except under very peculiar circumstances. Among these may be named Newcomen, Beighton, and Smeaton; but nothing essential was achieved except by the philosophical genius of Mr. Watt, then a mathematical-instrument maker at Glasgow. Being accidentally employed to repair a model of the then imperfect steam-engine, Mr. Watt observed that a great quantity of heat was lost by the unnecessary, and improper mode of condensing the steam: he completely obviated this defect, and by the introduction of a condenser *apart* from the cylinder, and an alternate action of the steam against each side of the piston, he effected every *essential* improvement of which this grand machine was then capable.

We do not, however, mean to say that Mr. Watt's improvements were confined solely to these objects. He also improved the mechanical arrangement throughout; but although in so doing he evinced the utmost in-

genuity, yet his exertions in this particular bear no sensible ratio to the magnitude of his other labours.

Mr. Watt obtained his first patent in 1769; but his first large engine was not completed till 1774. Finding his patent likely to expire before he had realized any advantages from his labors, Mr. Watt appealed to Parliament, obtained an extension of the term for twenty-one years, from 1775; and ultimately obtained the just meed of his unremited exertions.

Since Mr. Watt's Parliamentary Patent has expired, a variety of other improvements have been made by various mechanical gentlemen, and a species of steam-engine, termed "high-pressure," has been introduced. These high-pressure engines are, however, in many of their most advantageous points of construction, upon the principles previously laid down by Watt: and although they have a manifest advantage in their diminished size and consumption of fuel, yet are they attended with the serious risk of the most fatal accidents, by the *bursting of their boilers*. Messrs. Wolfe and Grevettire have most dis-

tinguished themselves in the construction of high-pressure steam-engines.

Steam-engines are now common all over the world; from England they have spread over the civilized surface of Europe. They are already known in India, and some hundred steam-boats, many of them of from five hundred to one thousand tons burthen, are worked on the immense inland waters of the American continent; as well as about our own sea-coasts, and those of the United States. A steam-ship—the Savannah—actually crossed the Atlantic Ocean from Savannah to Liverpool in 1819, from whence she proceeded to St. Petersburg.

STOCKING-FRAME.

KNITTING; — NETTING; — STOCKING-KNITTING; — ST. FIACRE; — ROWLEY'S POEMS; — CLOTH-HOSE; — INTRODUCTION OF KNIT-STOCKINGS INTO ENGLAND; — INVENTION OF THE STOCKING-LOOM; — ESTABLISHMENT OF THE STOCKING MANUFACTORY IN NOTTINGHAMSHIRE.

They who reproach the fair sex with the time lost in rendering themselves agreeable to the men, should not forget, that the former know how to pass those hours in useful employment, which the latter devote to mere social enjoyment. Among those lighter occupations of females, which serve to fill up vacant time agreeably as well as profitably, few possess so many advantages as that of knitting. It neither distracts the attention from conversation, nor checks the powers of the imagination—requires no ungraceful

position—occasions no straining of the sight—is performed as conveniently when standing or walking, as when sitting—may be interrupted without loss, and resumed without trouble—the whole apparatus costs but a mere trifle; and is so portable that it can occasion the fair artist but little inconvenience.

There are two methods of knitting, each essentially different from the other; the one employed for the purpose of weaving nets, the other of making stockings. The first is performed by knotting into meshes that cannot be unravelled; the second, by a certain arrangement of loops so connected with each other as to be highly elastic without separation, yet capable of being unravelled, and having the same thread applied to any other use. The former was well known to the ancients; but the Greeks and Romans were unacquainted with the use of hose, and the art of stocking-knitting is of much later invention. It seems more than probable that it was not discovered until the sixteenth century; but it is quite uncertain to whom, or even to what nation, we are indebted for it.

The earliest certain account of this kind of knitting is contained in the letters patent for the foundation, in France, of a corporation termed the *communauté des maítres bonnetiers au tricot*, dated in August 1527; and, from their having been then so numerous as to form a guild, we must suppose that the art had been already practised for some considerable time. These knitters chose St. Fiâcre,* who it seems was a Scotchman, for their patron; and from this circumstance, added to a tradition that knit-stockings were first brought to France from Scotland, a conjecture has been hazarded that the invention is due to the latter country. But, although the term *bonnetier*, in a general sense, implies hosier, it is probable that we should here confine it within its stricter meaning of bonnet-maker, for there is abundant proof that knit-stockings were not made in this country, until some years after the date of the French patent, and it is not credible that the English could have remained so long

* "*St. Fiâcre.*" See also the article *Coaches*, v. i. p. 100. A fair is annually held in his honor near Paris.

unacquainted with such an important invention of their nearest neighbours. Stowe, indeed, says, in his Chronicle, that the first stockings knit in England, of woollen yarn, were made in the year 1564, by William Rider, an apprentice of Master Thomas Burdet, who, having accidentally seen, at the shop of an Italian merchant, a pair of worsted stockings, from Mantua, borrowed them, and made another pair in exact imitation: but it must be admitted that the correctness of the date, if not of the fact itself, is exposed to suspicion.

The subject has been investigated with more than ordinary interest in consequence of the celebrated Chatterton's imitations of the poet Rowley having contained the following lines:—

> " As Elynour bie the greene lesselle was syttinge,
> " As from the sone's heat she harried,
> " She sayde, as her whytte hondes *whyte hosen were knyttinge*,
> " Whatte pleasure ytt ys to be married!"
>
> *Song by Sir Thybbot Gorges in the Entrelude of Ella*, 208.

As Rowley flourished about the middle of the fifteenth century, when the art of knitting was not supposed to have been known, they

who doubted the authenticity of the poems, insisted that the allusion to it was an anachronism, which, of itself, destroyed their claim to originality; while those who supported their genuineness, endeavoured to prove that the invention was older than was generally imagined. The result of the research occasioned by this memorable literary dispute has furnished us with the following particulars.

In Howell's General History, it is related, "that Henry VIII. wore ordinarily *cloth-hose*, except there came from Spain, by great chance, a pair of silk-stockings. King Edward, his son, was presented with a pair of long Spanish silk stockins, by Thomas Gresham, his merchant, and the present was taken much notice of. Queen Elizabeth, in the third year of her reign, was presented by Mrs. Montague, her silk-woman, with a pair of black knit silk stockins, and thenceforth she never wore cloth any more." However, a German writer* says, that Queen Elizabeth

* "*German writer*," Joh. Joach. de Rusdorff, Consilia et negotia politica, Francof. ad M. 1725.

was eighteen years on the throne before she wore silk stockings, when the Earl of Derby presented her with a pair that had been made at Milan.

With respect to the *cloth-hose*, it is probable that they were like our gaiters; for, in 1558, the fifth year of Queen Mary, we find that Dr. Sands, afterwards Archbishop of York, while confined in the Tower, had a pair of hose made for him *by a tailor.* This would go far to prove that knit stockings were not even then generally worn in England, were it not probable that the clergy and elderly people adhered for a long time to the old fashion. But, that woollen stockings were not only in use, but perhaps knit, in this country, during the reign of Henry the Eighth, seems placed beyond doubt by an authentic and curious household book kept in the family of Sir Thomas L'Estrange, of Hunstanton, in Norfolk, in which are the following entries:—

"1533. 25. H. 8. 7, Sept.—Peyd for 4 peyr of knytt-hose, viii *s.*"

"1538. 30. H. 8. 3, Oct.—Two peyr of knytt-hose, i *s.*"

the first mentioned, it is to be observed, were for Sir Thomas himself, the last for his children.

That stockings were considered at that period as a part of dress, is also proved by an estimate then made of the revenues of the Bishopric of St. Asaph; amongst which are enumerated, as perquisites on the death of every clergyman who held a living within the diocese,—"his best coat, jerkin, doublet, and breeches: item, his hose or nether stockings, shoes and garters." And in a collection of the Acts of Edward VI., printed in 1552,* is one for the regulation of the trade in woollen goods, in which mention is made of knitte peticotes, knitte gloves, and knitte hose."

About 1577, that is, within thirteen years after the anecdote recorded by Stowe, we find knitting spoken of as common throughout England; and two years after this, when Queen Elizabeth was at Norwich, several

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* This Act is not to be found among the *Statutes at large*: because, as it is said, it was repealed. The Editor of the collection alluded to above was Richard Grafton.

small female children were exhibited before her, some of whom were spinning worsted yarn, and others knitting worsted hose. But whether Stowe was correct in the date which he has ascribed to the invention, or that it should be placed at an earlier period, it is evident that it cannot be carried farther back in this country, than towards the middle of the sixteenth century.

The invention of the stocking-loom is thus recorded in the inscription to an old painting of one in the Stocking-Weavers' Hall, in London :—"In the year 1589, the ingenious William Lee, Master of Arts of St. John's College, Cambridge, devised this profitable art for stockings (but being despised went to France), yet of iron to himself, but to us and others of gold: in memory of whom this is here painted." In the picture Lee is represented pointing out the loom to a female knitter who is standing near him, and there is a story of his having invented the machine to facilitate the labour of knitting in consequence of his falling in love with a young country girl, who, during his visits, was

more attentive to her needle than to his proposals.

Lee, it seems, was a native of Woodborough, in Nottinghamshire, and he established his loom at Calverton, a village within a few miles of the county town, where he for some years carried on business. But meeting with no encouragement from Queen Elizabeth, to whom he applied for aid, and being, through the narrow commercial policy of the times, rather discountenanced in his undertaking, he accepted an offer from Henry IV. of France, and went with nine of his journeymen to Rouen, where he fixed his manufactory with equal credit and advantage. Henry, however, being, shortly afterwards assassinated, and civil commotions having arisen on his death, Lee was again neglected, and died in great distress at Paris. Seven of his workmen returned to England, and these, together with one Aston, who had been an apprentice to Lee, and was for some time a miller at Thoroton, laid the foundation of the stocking manufactory in this country, where it increased so rapidly, in the course of fifty

years, that the masters were incorporated by letters patent in 1663, and it has since become one of the staple branches of our trade.

In the petition for the patent, the machine is described as consisting of two thousand parts, and making, almost instantaneously, two hundred meshes; yet so ingeniously contrived, that this can be performed without either much skill or labour on the part of the weaver: the work performed by it is, technically, termed framework-knitting. The residence of Lee at Rouen has afforded the French a pretext for claiming the credit of this invention; but without the shadow of any real title. Unlike many great discoveries, it cannot be attributed to accident, but must have been the result of genius and deep reflection, and confers the highest honor on the memory of the inventor.

THREAD-LACE.

MODERN MODE OF KNITTING LACE;—POINT; BLONDE;—ANCIENT WORKED LACE;—INVENTION OF KNIT LACE;—ESTABLISHMENT OF THE LACE MANUFACTORY;—BRITISH LACE.

HALF a century ago, when a knowledge of many useful as well as ingenious arts formed part of the education of females in genteel life, it might have been considered superfluous, at least, if not absurd, to have offered any explanation of the mode of making lace; but as these have been superseded by other accomplishments, it is probable that they who are now the greatest consumers of lace are those least acquainted with the manner in which it is produced.

Thread-lace is not—technically speaking—woven: it has neither warp nor woof, but is rather knit somewhat in the manner of stock-

ings; except that in making these, only one thread is employed, and that in one uniform way, whereas lace is formed of as many threads as the pattern and breadth require, and disposed in such manner as that it may exhibit a diversity of figures. In order to knit lace, the pattern is drawn on a piece of parchment, and fastened to the cushion of a circular box with pins formed on purpose, which are stuck through it in various places, according to the design intended to be represented; the requisite number of threads are then wound upon small bobbins, one end being tied to each pin, and these are thrown over and under each other in various ways; so that the threads twine round the pins, and thus form that multiplicity of holes or eyes which produce the desired figure. Much art is not required in this operation, and it is far from being so ingenious an invention as that of weaving stockings in a loom. It is, however, extremely tedious; and when the thread is fine, and the pattern complex, it requires more patient attention than young ladies of the present day choose to bestow upon it: it has, therefore, been abandoned to indigent

females, who by their industry, and skill in the finer branches, thus raise the price of materials of small original cost to a higher value than in any other manufactory whatever, except perhaps some of those established at Birmingham, for the different fabrications of steel.*

When knit-lace has been worked with the needle, or embroidered, it is then termed *point*, the price of which is excessive; and when formed of silk, it is called *blonde*.

The antiquity of this art cannot be determined with precision: no passage in the Greek or Latin authors has any direct reference to it; and although some commentators consider the borders sewn upon the vestments of the Hebrews and the Phrygian work of the Romans, as lace, yet they would rather appear to have been some curious embroidery, the apparent ingenuity of which was probably magnified by its scarcity. Many

* "*Steel.*" It has been calculated, that a piece of steel, of the value of *five shillings*, may, by the mere operation of labour, be manufactured into as many watch-springs as would be worth *thirty thousand pounds*,

authors mention that it was invented in modern Italy; but this seems rather to allude to that kind made wholly with the needle, which is, doubtless, of much greater antiquity than that made by knitting. Lace of that kind is still to be found, on the continent, among old church furniture; but the process of making it is so slow, that it was probably confined to convents, and to ladies of fortune, who had little other employment for their time.

Knit-lace is supposed, with much appearance of probability, to have been a German invention; discovered, about the year 1561, at St. Annaberg, in Saxony. The person to whom the ladies are indebted for this elegant appendage to their dress is said to have been a female; and we take pleasure in recording the fact, both in honor of the sex, and as a tribute to the memory of the inventress, Barbara Uttmann. From Saxony the art speedily found its way to the Netherlands, and it was from Brussels that it was introduced into France, during the administration of the celebrated Colbert, in 1666. It was there, at first, confined to point-lace; and there was

an exclusive privilege granted to a Madame Du Mont and her four daughters, who established a manufactory in Paris, in which, within a short period afterwards, more than two hundred women found employment.

In this country, the manufacture of lace was slowly established; and, until within these few years, was far from keeping pace in improvement with other branches of our national industry. Prejudice, indeed, still gives the preference to foreign lace, although its superiority in the eyes of our modern belles may be fairly attributed rather to the excess of its price than of its real value; for, it is a singular fact, that, at a recent trial in the Court of Exchequer respecting some smuggled French lace, some of our most eminent dealers declared, upon their oaths, *that they could not distinguish the difference between it and that manufactured in England.*

VANES.

EARLIEST DISTINCTION OF THE WINDS;—DIVISION OF THE THIRTY-TWO POINTS;—TEMPLE OF THE WINDS AT ATHENS;—COLUMN AT CONSTANTINOPLE;—APPARATUS OF VARRO;—WEATHERCOCKS;—SHIP-VANES.

In the infancy of navigation, mankind had no particular names for distinguishing the principal winds, because for a long time they never ventured to go out of sight of the shore, and therefore had but little occasion to observe their course.

At first, names were only assigned to the four principal winds, which is most naturally accounted for by observing that the sun at noon stands always over one point of the horizon, which is called the meridian or south, and that directly opposite the north. If a person place himself with his face to the

north, he will have the east on his right, and the west on his left. Names were therefore first given to these four points, which were afterwards increased to eight in the time of Aristotle; but it is partly proved by a passage in Homer, where he intends to mention all the winds, but only enumerates four, that when he wrote, these only were distinguished. In the time of Vitruvius, twenty-four points were distinguished, though this division was but little used. The antiquity of the division into thirty-two points has not been determined. Some authors are of opinion that it has only been in use since the time of Charles the Great, but it has since been acknowledged to be of much greater antiquity. However, it is to be remarked, that in his time the ingenious method of denoting all the winds by the names and combinations of the four principal winds, was first adopted.

It is certain that vanes for ascertaining the direction of the wind were invented at a very early period; but the information given by Vitruvius respecting the tower built at Athens, by Andronicus Cyrrhestes, is the most ancient concerning any mode of observ-

ing the direction of the winds, and the earliest with which we are acquainted. This tower was built in the form of an octagon, on each side of which was carved an allegorical representation of the wind to which it was opposed, and the name was written above in large characters. On the summit was a copper triton, which pointed with a rod to that point from which the wind blew. The tower is standing, and the pedestal on which the triton was placed is still observable.

A pyramidal column, probably octagonal, on the summit of which was placed a female figure, made to turn with every wind, was certainly erected at Constantinople, the use of which appears to have been unknown to the Greeks. According to Cedrenus, this pillar was erected by Theodosius the Great; others ascribe it to Leo Isauricus. Were the first supposition correct, it would belong to the fourth century, and, in the second case only to the eighth; but it was probably constructed prior to the time of Theodosius. The female figure is called *Anemodoulon*, by Nicetus; by Cedrenus, *Anemoderion;* the former denotes a person belonging to the

wind, the latter one who contends with the wind.

Varro describes an apparatus at his farm, similar to that in use in many modern buildings, for ascertaining the state of the wind without examining it in the open air. Within the building was a circle in which the winds were represented, and an index, like that of a clock, pointed to the wind that blew.

In an account written before the year 1151, mention is made of a tower at Hems, in Syria, formerly called Emessa, on the top of which was a copper horseman, that was turned by the wind. In Europe, the custom of placing vanes on church-steeples is very old; and as they were made in the figure of a cock, they have been thence denominated *weather-cocks*. In the dark ages of ignorance and superstition, the clergy frequently styled themselves the cocks of the Almighty, whose duty it was, like the cock which roused St. Peter, to call the people to repentance, or at all events to church, and thence the cock was considered the emblem of clerical vigilance. These weather-cocks

are mentioned so early as the ninth century.

In France, in the twelfth century, noblemen alone were permitted to have vanes on their houses, and at one time, this privilege was only accorded to those who first planted their standards on the walls of a town when stormed.

The oldest information respecting vanes used on board ship, appears to be taken from the life of Emma, consort of Canute the Great, the author of which, describing the Norman fleet, sent to England in 1013, states that they had birds affixed to the tops of the masts, which indicated the direction of the wind. There is also in the cathedral of Bayeux, a piece of tapestry, representing the actions of William the Conqueror, and executed with the needle, either by his consort, or under her immediate direction, in which many of the ships are drawn with vanes at the mast-head.

WIRE-DRAWING.

EARLY MODE OF MAKING WIRE;—GOLD EMBROIDERY;—ANCIENT REMAINS OF WIRE;—INVENTION OF WIRE-DRAWING;—INTRODUCTION INTO ENGLAND;—FILIGRANE WORK;—SPANGLES.

In early periods, metals were probably beat into thin plates, and, being afterwards divided into small slips, were rounded by a hammer and file, so as to form threads or wire. The net in which Vulcan entrapped Mars and Venus, and which was so fine that the Gods themselves are represented as unable to perceive it, was forged, as the poets tell us, on the anvil. The mantle taken from the statue of Jupiter by the tyrant Dionysius, and the tunic of Heliogabalus, described by Lampridius, were woven entirely of gold threads. This invention is ascribed by Pliny

to King Attalus, but, it is more probable that Attalus first caused woollen cloth to be *embroidered* with threads of gold. In the Scriptures we also read, that when Aaron's sacerdotal dress was made, the gold was beaten and cut into threads so as to be interwoven with the cloth.*

There is not a passage to be found in any ancient author in which mention is made of metals being prepared by being wire-drawn. The *æs ductile* of Pliny was so termed because it was malleable, and works made with threads of metal are too rarely spoken of to allow us to suppose that they were formed otherwise than by the tedious process of the anvil. Very few remains of ancient wire-work have been discovered. In the museum at Portici are three metal heads, one of which has fifty locks of wire as thick as a quill, bent into the form of a curl; and a Venus, a span in height, has golden bracelets, made of wire, round the arms and legs. But the Romans must have possessed

* Exodus, ch. xxxix. v. 3.

gold-wire of considerable fineness, as mention is made of its being used by their surgeons in fastening false teeth.

The invention of wire-drawing may probably be classed among those of the fourteenth century, as in the History of Augsburg in 1351, and in that of Nuremberg in 1360, wire-smiths were called wire-drawers and wire-millers.

The finer kinds of work, especially in gold and silver, were best executed for a long time in France and Germany. A Frenchman, named Anthony Fournier, in 1570, brought the art of drawing very fine wire to Nuremberg, whither an artist of the name of Held also repaired from France, in 1592, and received an exclusive patent for his manufactory for fifteen years, which term was afterwards doubled. His patent also, by a grant from the Emperor Rudolphus II., 19th March 1608, included the manufacture of copper gilt with gold or silver. In 1612 his patent was renewed for fifteen years more by the Emperor Matthias, and, in 1622, was converted into a fief to the heirs male of the family of Held. All the wire made in Eng-

land was manufactured by hand until the year 1565 when the art of drawing it with mills was introduced by some foreigners. Some say that Jacob Momma and Daniel Demetrius, first established wire-making at Esher; and Anderson says, that the first flatting-mill was erected at Sheen, near Richmond, in 1663, by a Dutchman.

The machine for flattening wire to be spun round thread consists of two steel cylinders, moved by a handle, which compress the wire as it passes through them. The greatest improvement ever made in this art, was a machine driven by water, the axletree of which, by means of a lever, moves a pair of pincers, that open as they touch the drawing-plate, lay hold of the wire as it passes through a hole in the plate, and draw the wire back with them; but the inventor and the period of its invention are unknown: it has been ascribed to a man of the name of Rudolf, at Nuremberg, but this supposition is unfounded.

Filigrane works are of great antiquity, and appear to have been brought to Europe from the East. It was much used in church

ornaments in the middle ages, and there was formerly preserved in an abbey at Paris, a cross, ornamented with filigrane work, made by St. Eloy, who died in 665. Maria Euph. Reinhard, a female artist at Augsburg, who died in 1779, was celebrated for this kind of work.

Spangles are made by first twisting wire round a rod into the form of a screw; it is afterwards cut into single spiral rings, which are then placed on a smooth anvil and flattened by a smart blow of a hammer, so that a small hole remains in the middle, and the ends of the wire, which lie over each other, are closely united. They were first made in France, and from thence introduced into Germany, where they began to be manufactured in the beginning of the seventeenth century; but the invention is still older, as spangles, though of a coarse kind, are found on ancient horse-furniture, long prior to that period.

WOOLLEN MANUFACTURE.

EARLIEST MODE OF DRESS;—SHEEP;—SPINNING AND WEAVING;—ANTIQUITY OF THE WOOLLEN MANUFACTURE;—ROMAN MANUFACTORY;—DATE OF THE MANUFACTURE, IN ENGLAND; AND IN IRELAND;—FULLER'S AND CLOTHIER'S GUILDS;—WOAD;—YARN.

While mankind lived under the shade of their native palm-trees in the tropical region, where tradition has placed their origin, they had but little occasion to provide either food or clothing: the earth spontaneously supplied the former, and the warmth rendered the latter superfluous. But in proportion as they removed from their early abode, provisions became more scarce, and the climate more rigorous; and men then had recourse to the cruelty of killing animals, both to devour them as food, and to employ their

skins as a shelter against the severity of the weather.

Sheep came originally from Africa; but in that country the animal bears hair instead of wool, and it is only in colder climates that its covering gradually acquires a woolly texture. It may also be imagined that many centuries must have elapsed before sheep could have been conveyed to the northern counties, and before the inhabitants—thinly scattered, subsisting by the chace, and surrounded as they were by immense forests that produced in abundance all those animals which supplied the finest furs—could have been reduced to the necessity of employing artificial means to supply themselves with clothing. The northern tribes therefore continued to dress themselves in skins until a very late period of ancient history, and for ages after the arts of civilized life had been introduced among the inhabitants of the south.

The origin of the arts of spinning and weaving is lost in the obscurity of fable. The Egyptians ascribe the invention to their Isis, and the Hindoos trace it to the remotest period of their fabulous history; but this

applies only to cotton and flax, for in those countries, as we have already mentioned, wool is not produced. Varro says, that the sheep was introduced into Greece by Hercules, and it is probable that the first attempts to manufacture wool, in Europe, were made by the Athenians. Among both the Greeks and Romans, spinning was the chief employment of the women; the rites of marriage directed their attention to it; and the distaff and the fleece were not only the emblems but the objects of the most important domestic duties of a wife. The machinery employed in weaving, though perhaps rude in its construction, was, in principle, similar to that still in use; and the process of fulling and preparing the cloth seems to have resembled the modern practice in every material point, except that of shearing the nap, with which the ancients do not appear to have been acquainted. The chief seat of the Roman manufacture was at Padua, and that city still retains a portion of its ancient celebrity for the superiority of its workmen. It is worthy of remark that, although, at a late period of the Roman commonwealth, the domestic manufacture of wool

was abandoned to persons who made that their sole employment, and that it must have been carried on to a vast extent, in order to supply the wants of an immense population clothed almost exclusively in woollen, yet we no where read of cloth being measured; and it would appear that this arose from a custom of weaving no more cloth in one piece than was sufficient to form a single dress.

English historians generally attribute the establishment of the woollen manufacture in this country to the reign of Edward III.; but it has been ascertained by the ancient records of the Exchequer, that there were several guild fraternities of weavers established in various parts of the kingdom so early as the middle of the twelfth century. Thus we find it mentioned that in 1140, the weavers of Oxford pay a mark of gold for their gold:—

"The weavers of London, for their gild, £xvi.

"The weavers of Winchester one mark of gold, to have their customs and liberties, and right to elect the aldermen of their gold." And

"The fullers of Winchester £vi. for their gild."

These notices indicate, that fraternities of weavers were not only at that time common in England, but that the manufacture of cloth must have been of considerable extent and antiquity when it had given rise to guilds established by law.

In farther confirmation of the great antiquity of the art of weaving in England, Gervase of Canterbury, who wrote about the year 1202, says, in his Chronicle; (col. 1349,) when speaking of the inhabitants of Britain, that "*the art of weaving* seemed to be a peculiar gift bestowed upon them by nature." Thus it appears, that, at a period long prior to that which modern historians assign as the time when the woollen manufacture was introduced into Britain, it was an art that had been so long practised, as to be reckoned by its own inhabitants almost indigenous of the soil.

Sir Matthew Hale enables us, in some measure, to account for the origin of the modern idea on this head. For he remarks that " in the time of Henry the Second, and Richard I. this kingdom greatly flourished in the art of manufacturing *woollen cloth;* but, by the

troublesome wars in the time of King John and Henry III., and also Edward I. and Edward II., this manufacture was wholly lost, and all our trade ran in wools, and wool-fells and leather."

It is needless to observe, that a manufacture of such indispensable utility could not, in such a short period, be wholly lost in a country where it was once known. All that can be inferred from this expression is, that it declined very much; so as, in a great measure, to interrupt the foreign trade in cloth, which seems to have been a principal article of export from this kingdom at that early period. Edward III. restored this decayed manufacture, and hence he has come to be accounted the founder of it in England.

The above remark of Sir Matthew Hale perfectly agrees with the Magna Charta of Henry III., and there is an ordinance respecting the exportation of cloths, &c. by Edward I.

The richness and comparative importance of the fraternity of weavers, in the period here alluded to, may be guessed at from the following circumstances:—

"Anno 1159. The weavers of London stand charged with iij marks of gold for the farm of their gild for two years; the bakers of ditto with one mark and vj ounces of gold."

"1164. The weavers of London rendered £xij per annum for the farm of the gild; the bakers of ditto £vj per annum."*

In both these cases the weavers pay double of what is exacted from the bakers; hence it seems reasonable to infer that they were by much the richest fraternity of the two.

"1189. The fullers of Winchester pay ten marks for a confirmation of their privileges."† From this it appears that the fullers of Winchester still continued (as in the year 1140) a powerful fraternity.

That the business of dyeing was also carried on in these days as a separate, honourable, and profitable employment, may be inferred from the following record:—

"Anno 1201. David, the dyer, pays one mark that his manor may be made a burggage."

At this early period, woad seems to have

* Madox, Hist. Each. p. 231. † Ib. p. 274.

been very much employed as a material for dyeing. This plant was cultivated in Britain before the days of Julius Cæsar; and probably the cultivation of it would be much extended, as it came to be more demanded for the woollen manufacture in later periods; but this extended culture could not supply the increasing demand for this drug, insomuch that it was, for a great many ages, a constant article of import, as the following instance, among many others, fully shews :—

"Anno 1213. The following sums were accounted for by sundries as customs for woad imported, *viz.*

In Kent and Sussex (Dover excepted)	£103	13	3
Yorkshire	98	13	4
London............................	17	13	4
Norfolk and Suffolk	53	6	0
Southampton	72	1	10
Essex	4	2	4."

In all these places, therefore, the woollen manufacture seems to have been carried on to a great extent.

Many other anecdotes might be picked up in confirmation of this remark; among which are the following :—

"1140. The men of Worcester pay c. shillings, that they may buy and sell dyed cloth, as they were wont to do in the time of King Henry I." There is not the smallest reason to think that this was foreign dyed cloth, but British cloth, as alluded to in the ordinance of Edward I., already quoted, 1284.

"1225. The weavers of Oxford pay a cask of wine, that they may have the same privileges they enjoyed in the days of King Richard and King John."

"1297. The aulnager of cloth was displaced, and his office given by the King to another." The aulnager was a public officer to inspect cloths, so as to see that they were truly made according to statute. This indicates a very advanced state in the manufacture.

From these, and many other circumstances of the same kind that may be collected, there can be no room to doubt that the woollen manufacture was carried on as a great national object for several ages before the time of Edward III., at which period, our historians usually assert, that it was first introduced into England. And it was probably owing to the interruption it met with during the troublous reigns of John and his im-

mediate successors, that the manufacture came to be so firmly established in the Netherlands, as to obtain a superiority over the woollen manufacture of Britain, which it retained for many ages. It was also probably owing to this superiority that our forefathers lost the knowledge of many branches of this manufacture, which it is evident they once possessed; of this kind especially may be reckoned the art of dyeing and dressing cloths, which art was only revived in Britain at a very modern period.

If our historians have been thus mistaken with regard to the manufactures of Britain, it will not appear surprising that they should fall into similar mistakes in regard to the manufactures of Ireland. It is generally believed that the woollen manufacture was introduced into this last country at no very distant period; and in Anderson's History of Commerce, we find the first dawnings of it marked under the year 1376. But that woollen cloth was manufactured in that country a long time before that period, is evident, from the following curious anecdote preserved by Madox:

"In the reign of Henry III. (*i. e.* between

1216 and 1272,) Walter Blowberne accused Haman le Starre of a robbery, &c. whereof the said Haman had for his share two coats, *viz.* one of *Irish Cloth*, &c."* Irish cloth was, therefore, known in England at that period, which is at least one hundred years prior to that mentioned in the History of Commerce.

Although it is still doubtful whether the poems attributed to Rowley, a priest in the reign of Henry IV., are spurious or not, yet, as there has not yet appeared any irrefragable proofs that they are not genuine, a circumstance that occurs in them relating to this subject may be noticed as deserving some degree of attention.

This author points out Lincoln as being a place then noted for its fine woollen manufacture; for the dress of the Abbot of St. Godwin's, who is represented as living in great pomp, is thus described :—

> " His cope (cloak) was all of Lyncoln clothe so fyne,
> With a gold button fasten'd near his chyne,
> His autremete (a loose priest's robe) was edged with
> golden twynne," &c.
>
> *Ballad of Charitie, 50.*

* Hist. Excheq. p. 381.

In confirmation of this anecdote, it appears, from many particulars preserved in Hackluyt's collection, that, about this time, a very considerable trade in cloth was carried on between Boston—the port of Lincoln—and Prussia, and other places in the Baltic; and most readers of ancient poetry will recollect the frequent mention of *Lincoln green*, in the descriptions of ancient dress.

The following instances will serve to shew the degree of perfection to which the spinning of woollen yarn has been brought, within the last century.

In the year 1745, a woman named Mary Powlis, of East Dereham, in Norfolk, spun a single pound of wool into a thread of eighty-four thousand yards in length, wanting only eighty yards of forty-eight English miles; which was, at that period, considered as a circumstance of sufficient curiosity to merit a place in the records of the Royal Society. Since that time, however, Miss Ives, a young lady of Norwich, has spun a pound of combed wool, into a thread of one hundred and sixty-eight thousand yards; and her wonderful

success having induced her to try her talent upon cotton, she actually succeeded in producing from the same weight, a thread of two hundred and three thousand yards, equal to upwards of one hundred and fifteen English miles. It has been calculated that this last thread, if woven, would produce about twenty yards of yard-wide muslin: but it is said that even this extraordinary effort of ingenuity has been exceeded by an Irish flax-spinner in the county of Antrim.

WRITING-PENS.

ANCIENT MODE OF WRITING;—PAPYRUS;—CALAMUS;—REEDS;—ANECDOTES OF THEODORIC, KING OF THE GOTHS, AND OF THE ROMAN EMPEROR JUSTIN;—ANCIENT MS. COPY OF VIRGIL;—QUILLS;—GEOMETRIC PEN;—DRAWING AND MATHEMATICAL INSTRUMENTS.

The ancients were unacquainted with the fitness of quills for the purposes of writing. They chiefly employed tablets covered with wax, on which they engraved the characters with a metal style; and when they wrote with liquids on parchment, or on the paper then manufactured from the Egyptian papyrus, they made use of reeds.

It is singular, that notwithstanding the places where these reeds grew wild have been accurately designated, and the probability that they are still to be found in the same situations, we are yet wholly ignorant of the species to

which they belong. The authors who have treated on the subject have contented themselves with informing us, that they were formed of the *calamus:* but the genus of plants known to the ancients by that name is too numerous to allow of our determining it with any approach to certainty. The most beautiful of the kind grew in Egypt, in the district of Gnidus, in Asia Minor; in Armenia; and in some parts of Italy. Botanists have, indeed, explored these places, and learned conjectures have been formed respecting the particular class to which it should be assigned; but with so little success, that it has not found a place in the botanical system of Linnæus.

It is also remarkable, that reeds are still employed to write with by many of the eastern nations. We learn from the voyages of Chardin, Tournefort, and others, that these are small hard canes about the size of large swan-quills, which they cut and split in the same manner that we do quills, except that they give them a much longer nib. The best are collected in some places bordering on the Persian Gulph, whence they are sent

throughout the East. They are deposited, for some months after they are cut, under a dunghill, where they assume a mixed black and yellow colour, with a fine polish, and become hard; but the latter quality is accompanied with a want of elasticity which deprives them of the most material advantage of our pens; and it has been not unaptly remarked, "that had the ancients been acquainted with the art of employing quills for this purpose, they would probably have dedicated to Minerva, not the owl but the goose."

It has been supposed, that quills were made use of for writing so early as the fifth century; but the conjecture rests merely upon an anecdote of Theodoric, king of the Ostrogoths; who, being so illiterate that he could not write even the initials of his name, was provided with a plate of gold, through which the letters Theod. were cut, and this being placed on the paper, when his signature was required, he traced the letters *with a quill.* A similar method was employed by the Roman Emperor Justin, who reigned at a somewhat later period; and it is remark-

able, that in an age not destitute of learning, two nearly contemporary monarchs, whose talents had raised them to the throne, had never been instructed in the knowledge of the alphabet. Of more importance is the fact, that the Medicean library contains a manuscript copy of Virgil, written early in the fifth century, in which the gradual fineness of the hair strokes would lead to the conclusion, that it must have been written at least with some instrument as elastic as a quill; but it is unaccompanied by any further proof.

The earliest certain account of the modern writing-pens dates no farther back than 636; and the next occurs towards the latter end of the same century, in a Latin sonnet to a Pen, composed by Adhelmus, a Saxon author, and the first of his nation who wrote in that language. After that period, there are numerous proofs of their having been generally known; but they were so far from having, at once, superseded the use of reeds, that persons well versed in the comparison of ancient manuscripts affirm, that the latter were commonly used in the eighth century.

Even at a later date, the papal acts, and those of the synods, were written with them; and even the use of the metal styles and waxen tablets was not entirely abandoned until the commencement of the fourteenth century. Quills, indeed, would appear to have been for a long time as scarce as reeds are at present, if we accept the testimony of the monk Ambrosius, who, in a letter accompanying a present of quills, sent from Venice in 1433, thus expresses himself: "show the bundle to brother Nicholas, *that he may select a quill.*"

Pens could not, with propriety, be ranked among the mechanical inventions, were it not for the variety of ingenious improvements that have been made in metallic pens, for facilitating both writing and drawing. Among these the geometric pen is by far the most curious. By this small machine, a right line, a circle, an ellipse, and other mathematical figures may be described. It was invented by John Baptist Suardi, who wrote a treatise on the subject; for although several writers had observed the curves arising from the compound motion of two circles moving

round each other, Suardi was the first to realize the principle, and to reduce it into practice. The number of curves this instrument can describe, the inventor enumerates at 1273, which, he says, can all be delineated in the simple form.

The fountain-pen which supplies itself with ink; the port-crayon, and other drawing and mathematical instruments known under the denomination of pens, as well as the penna duplex, for making a double copy of any writing at one time, are all too well known to require description.

BOOK IV.

ON

DISCOVERIES

IN

SCIENCE.

K 6

ADULTERATION OF WINE.

VINOUS AND ACETOUS FERMENTATION;—SUGAR OF LEAD; ANTIQUITY OF THE ADULTERATION OF WINE;—SULPHUR;—LITHARGE;—SEA-WATER;—MUSTO COTTO;—STUM-WINE;—MODERN ADULTERATIONS.

THE writings of a celebrated chymist* of the present day, have led the public to suspect that few articles of daily consumption, in London, escape adulteration. In no instance, perhaps, has it been more extensively practised, throughout Europe, or with consequences more prejudicial to health, than in that of wine.

The juice of the grape, when expressed, is subject to two distinct degrees of fermentation—the vinous, and the acetous: by the

* Accum, on Culinary Poisons.

first it becomes wine; but the progress from that to the second, by which it loses its spirit and becomes combined with acid, is almost imperceptible, and, when the liquor is weak, is frequently rapid. The progress of the vinous fermentation, if properly attended to, may, indeed, be checked; but once the acetous fermentation has commenced, it is impossible to restore the wine to its original state. Ingenuity, however, has been variously exerted to render the acid in wine, thus spoiled, imperceptible; so that, they who do not possess an accurate judgment in such matters not unfrequently purchase sweetened vinegar in lieu of wine. Were this the only consequence of the fraud, it would not form a subject for serious alarm; but as mere saccharine juices cannot be used in sufficient quantity to conceal the acidity without betraying themselves, the dealers have had recourse to another expedient, more certain in its operation, and more injurious to the consumer.

The substance thus employed is sugar of lead (*saccharum saturni*), which, when dissolved in the acid that spoils wine, gives to

the liquor a saccharine taste that is not unpleasant, without affecting either the colour or smell, while it effectually stops the fermentation; but it communicates, at the same time, the noxious quality of occasioning, according to the quantity used and the constitution of the consumer, violent cholics, obstructions, and other diseases, which sometimes end in death; so that, as Beckmann observes, it may be justly doubted, whether Mars, Venus, or Saturn is most destructive to the human race. It is, however, consolatory to reflect, that the strength of the wine usually imported into this country, secures it in a great measure from acidity, and consequently renders this practice less frequent than on the Continent; but there, it is very generally employed *to correct,* as it is termed, the small wine in most common use, and no where more extensively than at Paris.

It would appear that the ancients were aware that lead both ameliorated harsh wine, and preserved it from acidity, and that the acid of wine had the power of dissolving it; for when the Greek and Rome wine-merchants wanted to know whether their wine

was spoiled, they immersed in it a plate of lead, which could only be to observe whether the colour of the lead was changed by corrosion. They were also acquainted with a mode of improving and clarifying wine by boiling it with lime, or gypsum; which method is supposed to be still practised in some parts of Spain, and in the island of Zante: but is considered no farther prejudicial than as it tends, if used in too large a quantity, to deprive the liquor of its spirituous parts. That the custom is of very ancient date in the former country, is proved by a decree of the States of Arragon, in 1348, prohibiting its use.

The practice of adulterating wine is, indeed, almost as old as the liquor itself; and so invariably has it been continued, that every age of which we possess the records furnishes some edicts against its continuance. Some of these enumerate the articles used for that purpose, among which we find vitriol, quicksilver, lapis caliminaris, and sulphur: the latter, however, is certainly innoxious, and is supposed to be much used in the preparation of some qualities of white

wine, at Bordeaux. The mode in which it is employed, is that of fumigation, by kindling linen rags dipped in melted brimstone, and allowing the vapour to enter the cask; and its effects are, to confine the fixed air contained in the wine, and to stop its fermentation. Some wine-merchants, however, sprinkle these rags with bismuth, which, should it fall into the liquor, may have a very prejudicial effect on the health. It was indeed, at one time, supposed to have been attended with such baneful consequences, that its use, and that of litharge, had nearly ruined the wine-trade of Wurtemberg; and, in 1697, this species of adulteration was forbidden throughout that kingdom, on pain of death. It was not, however, until one extensive dealer had been beheaded, and others severely fined, that the practice was checked, and although it has since been concealed with more caution, it undoubtedly is not annihilated; for even in this country, and in the present century, a treatise has been published on the art of making wine, in which the use of litharge is openly recommended as being entirely free from danger.

The presence of metals in wine may be detected by the application of arsenical liver of sulphur; but its use is not decisive of the particular kind employed, as it precipitates all metals black without any distinction: and if gypsum should have been added, the colour of the precipitate will be altered by that of the earth.

Among the innocent articles with which wine has been mixed, we find mustard and mugwort mentioned, in the year 1484, and, in the following century, milk was included in an imperial ordinance against adulteration. The effects of the latter, however, are only to clarify the liquor, and to render the tint more pale, and are otherwise wholly imperceptible: it was known to the ancient Grecians; and is still used in small quantity, and for white wine alone. But the most extraordinary addition of all was employed by that people, not to adulterate but to ameliorate their wine; for which purpose, we are assured by many old authors that they sometimes mixed it with sea-water.

The Greeks and Romans used also to boil much of their wine until only a certain por-

tion of it remained; and when by this operation it was deprived of some of its watery particles, it was mixed with honey and spices. This method, with the exception of the mixture of spice and honey, is still applied to some kinds of new wine in Italy; where it is now, however, only used for salad and sauces, under the name of *musto cotto.* It is said, to be also employed in the preparation of the Spanish and Hungarian sweet wines; but the fact is exposed to considerable doubt.

There is, also, another mode of preparing wine, which cannot properly be called adulteration, but which was formerly considered so unwholesome as to have been prohibited in Germany, in 1472. It is effected by stopping the fermentation at a certain period, by which the original sweetness of the grape is in great part retained, and on being exposed to the air, the fermentation recommences. The prejudice against this method no longer exists, and it is frequently employed in Germany and France: the common appellation of wine thus treated, is *stum wine;* but the French, who prepare considerable quantities

in this manner, at Bordeaux, denominate it *vin en rage.*

Mr. Accum tells us that in London "Brazil wood, or the husks of elder-berries and bilberries are employed to impart a deep rich purple tint to red port of a pale, faint colour; that gypsum is used to render cloudy white wine transparent; that an additional astringency is imparted to immature red wines by means of oak-wood, saw-dust, and the husks of filberts; and that a mixture of spoiled foreign and home-made wines is converted into the wretched compound frequently sold as genuine old port. Various expedients are resorted to for the purpose of communicating particular flavour to insipid wines. Thus a nutty flavour is produced by bitter almonds; and the ingredients employed to form the *bouquet* of high-flavoured wines, are sweet-briar, orris-root, clary, cherry-laurel-water, and elder flowers."

"There is in this city," he says, "a certain fraternity of chemical operators, who work under ground in holes, caverns, and dark retirements, to conceal their mysteries from the eyes and observation of mankind.

These subterraneous philosophers are daily employed in the transmutation of liquors, and by the power of magical drugs and incantations, raising under the streets of London the choicest products of the hills and valleys of France. They can squeeze claret out of the sloe, and draw champagne from an apple; an art which Virgil seems to have had in view in that remarkable prophecy,—"

"*Incultisque rubens pendebit sentibus uva.*"

Eclog. iv. v. 29.

"The ripening grape shall hang on every thorn."

Dryden.

ALUM.

ROMAN ALUMEN;—MODERN ALUM;—USES;—DISCOVERY; ANCIENT ALUM WORKS;—MINES AT CIVITA VECCHIA; JOHN DE CASTRO;—MONOPOLY OF THE POPES;—ENGLISH ALUM WORKS;—ROMAN ALUM.

It has been generally supposed that the substance which the Romans termed *alumen* was the same as that distinguished by us under the denomination of alum: but this affords an instance how frequently names are improperly applied without sufficient examination.

The ancients were certainly unacquainted with the crystallized alum of the moderns; and what they called *alumen* was, in fact, nothing else than that species of impure vitriol so frequently found in mines, and which is often

little more than vitriolic earth. Pliny, indeed, speaks of blue vitriol being obtained in Spain by the process of boiling; but he mentions the circumstance as singular, and no trace of any other works for the preparation of either vitriol or alum is to be found. Neither the Greeks nor Romans, indeed, speak of any other than natural alum, and every thing related by them coincides with the description of natural vitriolic substances, while alum is seldom produced spontaneously in the earth, and some acute mineralogists even deny the existence of natural alum.*

* Tournefort thus mentions a substance of this kind, which he discovered in some caves in the island of Milo, in the Levant, which place was celebrated for its alum in the time of Diodorus Siculus, and Pliny. "They are vaults of about four or five feet in height, incrusted with alum nearly throughout. This alum is formed in flat laminated pieces of about an inch in thickness. The solution of this natural alum is sourish and styptic; it ferments and coagulates oil of Tartar in the same manner as purified alum, from which it only differs by containing a larger portion of stony matter. The quill alum, which is also found there, possesses the same properties. It is found in large pacquets composed of threads as slender as the finest silk, of a shining silver colour, and from one to two inches in length."

Voyage au Levant, tom. i. p. 63., ed. 1718.

The close affinity between the two substances has led to the error: they are both neutral salts; both are, from their astringent qualities, comprehended under the common description of styptic salts; and they contain an acid which is, in each, called vitriolic. They can also be generally employed for similar purposes; they are usually found in the same places; and the only essential difference is, that vitriol is combined with metallic earth, of either copper, zinc, or iron, and alum with a peculiar white earth which bears its name.

It is, however, true, that the vitriolic mineral earths will sometimes produce alum, or at least that where these abound, there are usually other mineral earths, from which alum can be obtained; but this is a modern discovery, and is due to a chemical process with which the ancients were not acquainted.

One of the chief uses of alum is to fix the colours used in dyeing, and to render them more brilliant: for this purpose the natural *alumen* was also employed; but it fell into disuse when the modern invention was made known, and to this latter the name of alum

was then distinctively applied. Real vitriol, however, maintains a superiority in some medicinal qualities, and in the process of dyeing black.

Of late years, a preparation of alum has been recommended as a security against the destructive consequences of fire, and this has been generally considered as a novel application of its powers. But an inquiry into the uses to which the ancients applied their *alumen*, shows that it was employed for the same purpose, and in a similar manner; for we learn from Gellius, that Archelaus, a general in the service of Mithridates, washed over a wooden tower with a solution of it, and this rendered it so impervious to fire, that all Sylla's attempts to set it in flames proved ineffectual. A similar instance is also recorded by Ammianus Marcellinus.*

* These curious passages are as follow:—

"Tum Sulla conatus est et tempore magno eduxit copias, ut Archelai turrim unam, quam ille interposuit, ligneam incenderet. Venit, accessit, ligna subdidit, submovit Græcos, ignem admovit; satis sunt diu conati, nunquam quiverunt incendere; ita Archelaus omnem materiam obleverat alumine.

 Quod

It has, indeed, been conjectured that the substance employed on these occasions was not *alumen*, but *asbestos*, which has been sometimes confounded with atlas-vitriol; but the difficulty of covering a building with the threads of this fossil, and its being soluble in water, render this supposition incredible.

The origin of our present alum seems to have taken its rise in the East; and the period of the invention, though not exactly ascertained, was certainly subsequent to the twelfth century. Its use in the art of dyeing first brought it into notice: this application of it was, therefore, also learned from the Orientals, who, notwithstanding the advantages which the Europeans possess in the

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Quod Sulla atque milites mirabantur, et postquam non succendit, reduxit copias."

Aul. Gell. Noct. Att., lib. xv. cap. 12.

"Persæ aggerum altitudine jam in sublime porrecta, machinæque ingentis horrore perculsi, quam minores quoque sequebantur, omnes exurere vi maxima nitebantur; et assidue malleolos atque incendiaria tela torquentes laborabant incassum; ea re quod humectis scortis et centonibus erant opertæ materiæ plures, aliæ unctæ alumine diligenter, ut ignis per eas laberetur innoxius."

Amm. Marcel., lib. xx. cap. 12.

modern improvements in chemistry, still retain a superiority in the beauty and durability of some of their colours. The earliest of these alum works are said to have been established at a place called *Rocca*, in Syria, the exact position of which it is now difficult to determine; but it is probable that it was either Rocca on the Euphrates, or Edessa in Mesopotamia, which is also sometimes called *Roccha*. The point, however, is of no further importance, than as it is by many supposed that the common name of *roch-alum* was thence derived, and not, as others think, from *alun-de-roche*, or *rock-alum*, from this substance being sometimes obtained by the process of boiling mineral stones. Towards the middle of the fourteenth century, there were alum works in the neighbourhood of Constantinople, at Trebizond, and in various parts of the Levant; and in the reign of the Emperor Constantine II., in the following century, there was a celebrated manufactory at Foya Nova, in the vicinity of Smyrna, from which this country and the greatest part of Europe was then supplied. Of the latter a

description has been recorded by Ducas,* from which we learn that the stones found on the neighbouring mountains were calcined and reduced to a powder, which was afterwards boiled until a residuum was formed, in substance like coagulated milk; this was then poured into vases, and allowed to subside during four days, at the end of which period the alum was found congealed in resplendent crystals around the edges and at the bottom of the vessels.

It seems probable that the first alum works in Europe were established about the year 1459, in the Island of Ischia, on the coast of Tuscany, by a Genoese merchant named Bartholomew Perdix, who had learned the art at Rocca; but the most ancient in existence are those still carried on in the neighbourhood of Civita Vecchia, in the Ecclesiastical States. The founder of these was John de

* This "*Ducas*" must not be confounded with the "Theodore Ducas," whose name has been lately affixed to some amusing but fictitious travels. The work alluded to in the text is entitled *Historia Byzantina, res imperio Græcorum gestas complectens a Joannes Palæologo I. ad Mehemetem II.*

Castro, the son of a celebrated lawyer, who flourished at Padua in the beginning of the fifteenth century. He had been established as a merchant at Constantinople, where he acquired a considerable fortune by dyeing Italian cloth, which in those days was sent there expressly for that purpose; but having lost all his property when the city was taken by the Turks under Mahomet II., in 1453, he returned to his native country, and obtained the office of Commissary of the Revenues of the Apostolic Chamber. This gentleman, having observed that the grass on the mountains in the vicinity of Tolfa, in the before-mentioned district, had a peculiar colour, and that some white stones of a mineral appearance were impregnated with a saline taste, conjectured that they contained alum, and made the circumstance known to his patron Pope Pius II. But his discovery was at first looked upon as the visionary dream of an enthusiast, and it was long before the necessary experiments were made, in order to ascertain its correctness. When this, however, was proved, it was hailed as a victory over the Turks, to whom large sums were

annually paid for the alum used in dyeing; and de Castro was not only rewarded with a portion of the profits, and elevated in rank, but was even considered worthy of a statue, which was accordingly erected to him, in Padua, with the inscription—"*Joanni de Castro, Aluminis inventori.*"

The large revenue which soon flowed into the Apostolic chamber from the sale of alum, induced many persons to search Italy for aluminous minerals; and, as they are found in many parts of that country, numerous works for boiling them were speedily established. The Pope, however, understood his own interest too well to allow of these being carried on; and, besides, used every means in his power to secure a monopoly by preventing foreigners from obtaining a knowledge of the process. The price, however, was gradually raised to such an exorbitant height, that the other nations of Europe again began to purchase it from the Turks; but his Holiness then called religion to his aid, and announcing that the profits of his alum were to be applied to the defence of the church, he prohibited all Christians from

purchasing this drug of the infidels, under pain of excommunication. Succeeding Popes followed this pious example, and the Holy See continued in possession of its monopoly until the doctrines of Luther taught heretics no longer to dread its malediction.

In England, the first alum-works were established towards the close of the sixteenth century, and are thus mentioned in Pennant's Tour in Scotland:—" The alum-works in this country are of some antiquity; they were first discovered in the reign of Queen Elizabeth, by Sir Thomas Chaloner, who observing the trees tinged with an unusual colour, made him suspicious of its being owing to some mineral in the neighbourhood. He found out that it abounded with an aluminous salt. At that time, the English being strangers to the method of managing it, there is a tradition that Sir Thomas was obliged to seduce some workmen from the Pope's alum works near Rome, then the greatest in Europe. If one may judge from the curse which the Pope thundered out against Sir Thomas and the fugitives, he certainly was not a little enraged, for he cursed by the

very form that Ernulphus has left us, and not varied a tittle from that most comprehensive of imprecations.* The first pits were near Gisborough, in Yorkshire, the seat of the Chaloners, who still flourish there, notwithstanding his Holiness's anathema." It is not a little remarkable that, since that period, the proprietors of the English works have farmed those of the Roman Pontiff, and even increased the benefit that the Holy See formerly derived from them: they employ about two hundred men; the produce is of a superior quality, and bears the highest price in the different markets of Europe, where it is well known under the denomination of *Roman alum.*

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* "*Imprecations.*" Such of our readers who may not choose to search into Ernulphus, will find the form at full length in *Tristram Shandy.*

AMALGAMATION.

PROPERTIES OF QUICKSILVER;—AMALGAM;—PERUVIAN MINES;—ALONZO BARBA.

QUICKSILVER is well known to unite very readily with almost every metal, and, when added in large quantities, to form a paste, capable of being kneaded, which is called amalgam. It is likewise of great utility in decomposing gold and silver from the earth and stones in which they are buried, as it is incapable of uniting with earth, on account of its being a metallic substance. The amalgam is squeezed through a piece of leather, which contains the gold and silver, mixed with a certain quantity of the quicksilver, which is separated from the former metals by evaporation caused by fire. Amalgam

made with gold serves also to gild other metals, if rubbed over them, and afterwards heated until the quicksilver evaporate.

It is generally supposed that the use of quicksilver was first discovered in Spain about the middle of the sixteenth century; but Pliny assures us that the ancients were acquainted with amalgam, both for separating gold and silver from the particles of earth with which it is surrounded, and for gilding. Vitruvius also mentions the manner of separating gold from cloth, by fire, after it has been interwoven with it; the ancients, however, used always to lose the quicksilver by evaporation, which is now preserved by means of a retort.

The gold found in rivers is likewise separated from the sand by means of quicksilver, which method was probaby known in Germany, prior to the discovery of the mines in America, as, in the year 1582, John Michael Herberer described this operation as he saw it practised at Selz, near Strasburg, where quicksilver had been long employed for the purpose of washing gold.

Mercury was first introduced into Peru, in the year 1571, for the purpose of refining the silver found in the mines, by Pero Fernandez de Velasco, who had studied this process at the smelting-houses in Mexico, where it had been long practised. Quicksilver was found to be contained in the red earth of Peru called *limpi*,—which the Indians use for paint, but which is, in fact, native Cumabar,—by Henry Garces, who thus laid the foundation of the quicksilver mines, which were afterwards employed with such success for refining silver by Velasco.* Quicksilver was a free article of trade until this period, when it became the exclusive property of the Crown.

A work on metallurgy, and the use of quicksilver in refining gold and silver, was written by Alonzo Barba, a clergyman of the church of St. Bernard, at Potosi, in the year

* These mines are situated in an extensive ridge of mountains, at no great distance from the city of Lima, and are called Huancavelica. Their discovery is fully related in the *Historia naturale e morale delle Indie*, of the Jesuit Acosta; a work which abounds with curious and valuable information.

1640, who has by some writers been supposed to be the inventor of amalgamation. He discovered the process by mere accident: for being desirous of fixing quicksilver, he mixed it with fine pounded silver ore, and soon found that the mercury had attracted every particle of silver to itself, which presented him with the idea of refining metals by means of quicksilver. This experiment he made in the year 1609, but he was probably unacquainted at that time with the smelting-works in America, and does not appear desirous of claiming the invention of amalgamation as practised in that country. The book, though published at that late period of the art, and notwithstanding there were many superior treatises on the same subject already published in German, was considered of such importance by the Spaniards, as containing all their metallurgic secrets, that they endeavoured to suppress it; and it actually became an object of attention to the British ambassador, who having obtained a copy, as a great rarity, commenced a translation of it into English, but only completed

the first part. This version was afterwards published in London, in 1674, under the title of "*The First Book of the Art of Metals, in which is declared the manner of their Generation, and the concomitants of them; written in Spanish by Albara Alonzo Barba, translated by Edward Earl of Sandwich.*"

AQUA-FORTIS.

MINERAL ACIDS;—WATER OF NITRE;—PHILOSOPHER'S STONE;—AQUA-CHRYSULCA;—SEPARATION OF THE PRECIOUS METALS;—VAPOUR OF AQUA-FORTIS;—INTRODUCTION OF THE MODERN METHOD OF REFINING.

It is not easy to trace the earliest mention of mineral acids among the writings of the ancient chemists. They had, indeed, at a very early period, discovered various acids, the virtues of which they highly extol; but they generally endeavoured to conceal the process by which they were obtained; and either with this view, or from ignorance of the proper method of extracting them in a pure state, and of distinguishing their several qualities, their receipts are found to be so confused and contradictory, that it is frequently difficult even to conjecture to which of the known acids they refer.

The oldest intelligible account of aqua-fortis appears to occur in the writings of the Arabians, or at least in those of the pupils of Arabian chemists, amongst whom Geber seems to be the most ancient. The period at which this author wrote is, however, uncertain: some have ascribed it to the eighth or ninth century, and others, with more appearance of probability, to the twelfth. The age in which the Greek alchymist Synesius lived is also unknown; but it is apparent that he borrowed largely from the Arabians. A manuscript copy of his works was preserved in the library at Venice, from which some extracts have been published, in which mention is made, among the chemical solvents, of the *water of nitre*, which may probably be considered as aqua-fortis. The German monk Theophilus, also a very early writer, likewise speaks of a liquid which dissolved all metals; but the date of his works is equally undetermined. Some vague traces of aqua-fortis are, however, to be found in the works of the chemists of the thirteenth century: Lullius, who died at a very advanced age in 1315, is said to have produced it from salt-

petre with the addition of vitriol; and Basil Valentin, at a later period, was acquainted with a process for the same purpose.*

There is an old tradition that this acid was first employed at Venice in the analysis of the noble metals; it was in use there at the period of the discovery of America, and was chiefly applied to the separation of the gold from the Spanish silver, by which operation vast wealth was acquired. Hence arose a very prevalent report that the Venetians had discovered the art of making gold; and, indeed, the gold refiners of every country were for a long time generally supposed to be in possession of the philosopher's stone. The epoch of the introduction into Venice of this manner of separating metals, instead of that by fire, as more anciently practised, is, however, as uncertain as that of its original discovery, and we only know that it is spoken of in a work, published by William Budé, in 1516, as a recent invention.† In this book

* For some account of "*Basil Valentin,*" see the Art. "*Fulminating Powder.*"

† "*Budé,*" De Asse, fol. lib. iii. p. 101.

its first employment in France is ascribed to one Le Cointe, a man of low extraction, who, late in the fifteenth, or early in the sixteenth century, began to separate gold from silver by means of a liquid called *Aqua Chrysulca;* and it is remarkable that, with its assistance, he could not only divide the smallest particle of gold from silver or any other metal, but even remove the gilding from vessels without injuring them; which would prove that *aqua-regia* was also then known, as without it that operation could not be performed. He could extract the silver from the finest gilt wire, so that the gold would remain in the form of a tube, and the silver being dissolved by the aqua-fortis—which in this case must have been the liquid employed,—was afterwards separated from it by another process.

By this art Le Cointe realized a large fortune; but its exercise was considered not only unhealthy but dangerous, and it is said that, when he had become rich, he used to entrust the execution of the work to a servant, whom he directed at a distance, in order to avoid the pernicious fumes arising from the effervescence of the corrosive liquor.

The vapour of aqua-fortis, or even that of saltpetre alone, is doubtless injurious to the constitution, but the danger to be apprehended has been exaggerated, probably with a view to deter people from attempting to discover the secret of the art, as well as to enhance the value of the production; and hence have, in a great measure, arisen the stories which are told of masks being used in some chemical operations, although it is evident that they can only protect the eyes, and not the lungs.*

After Le Cointe's death, his son, who it appears was then the only gold refiner in Paris, sold the secret to the Mint; and there is a decree of Francis I., issued at Blois in 1540, raising the value of the coin in consequence—"in order to defray the expense of the assaying water."

From these facts it would appear, that this method of refining was not known in Europe until late in the fifteenth century, although

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* Respecting "*the use of masks in chemical operations*," see the account of the death of the Chevalier de St. Croix, in the article "*Slow Poison*."

some authors pretend that it was practised in France so early as 1403, in which year letters patent were granted at Paris to one Dominick Honeste, a Genoese, for the separation of gold and silver (*"pour départir les matières d'or et d'argent"*); but there is no proof that he employed any other than the ancient mode. Whether it was known to the Arabians is questionable, as their knowledge of aqua-fortis has not, as we have already seen, been accurately ascertained; although from their early acquaintance with the properties of nitre, it is probable that this liquid was obtained by them at a very remote period.

ARTIFICIAL PEARLS.

NATURAL PEARLS;—ARABIAN METHOD OF PRODUCING PEARLS;—CHINESE METHOD;—PEARL-OYSTER;—LINNÆAN DISCOVERY;—PEARL BEADS;—PEARL ESSENCE;—PROCESS OF MAKING FALSE PEARLS;—PERIOD OF THE DISCOVERY;—ANECDOTE.

NATURAL pearls are calcareous excrescences, which are found as well in the bodies as in the shells of several kinds of crustaceous fish. The supposition that they are only produced in one peculiar species of oyster is a popular error: they have been discovered in the shield of the sea-hare (the *aplysea depilans* of the *systema naturæ*), in some kinds of muscles, and even in the common Colchester oyster. The delicate lustre which they derive from the enamel with which they are encrusted, has ever rendered them favourite ornaments of the fair-sex; and so ancient is

their use, that we find them alluded to as articles of value, in the Scriptures.*

It is well known that they were considered by the ancients among their most costly jewelry; but as we learn from the elder Pliny, that they were worn in the time of Nero by the wives of even the inferior public officers, and as it has been ascertained that the Romans were not acquainted with the art of making false pearls, it seems probable that some mode had been early invented to hasten, or perhaps even to occasion, their natural formation. This art, indeed, is known to have been practised in the first centuries of the Christian æra by the natives of the shores of the Red Sea; and we are told by Philostratus, in his life of Apollonius, that it was effected in the following manner:—

"The Arabs first poured oil upon the sea, which it is well known has the effect of calming the agitation of the waves, and consequently of rendering the water more transparent at the bottom.† They then dived in

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* *Scriptures.* Job, ch. xxviii. v. 18.

† See the remarks on this subject in the article "*Diving-Bells.*"

those spots where they knew the fish were to be found, and enticed them to open their shells by rubbing them with some kind of ointment as a bait; which having effected, they pricked them with a sharp instrument, having first placed near them a vessel hollowed out in various places into the form of pearls, into which moulds the liquor which flowed from the wound was received, and there hardened into the shape, colour, and consistence of the native gems."

No explanation is given of the necessity for performing this operation under water, instead of catching the animal and carrying it to the surface; nor is it said whether the vessel in which the pearls were thus formed was left in sea-water, or exposed to the air. The art is now lost, and we are not yet sufficiently acquainted with the nature of shell-fish to be enabled to determine the degree of credit due to the account; but a process still employed by the Chinese to cause a peculiar species of the muscle to produce pearls, seems to confirm the account given by Philostratus.*

* *Philostrat. in vita. Apollon.* lib. iii. c. 57.

At the commencement of summer, when the muscles rise to the surface of the water and open their shells, a few small beads of mother-of-pearl, strung together on a thread, are thrown into them. At the close of the year the muscles are drawn up and opened, when the beads are found covered with an enamel in all respects similar to that of real pearls. Sharp bits of wire dropped into the shells have also been found encrusted in the same manner; and it has been conjectured that the fish had covered them with this substance to protect itself against the points. It is also certain that the pearl-oyster possesses the power of filling up any small openings made in their shells with a calcareous substance which assumes the figure of the orifice; and pearl-fishers are aware that those shells which are rough and irregular usually contain pearls. But it must likewise be admitted, that the most valuable pearls are not found adhering to the shell.

In 1761, the celebrated Linnæus declared that he had discovered the art of forcing muscles to produce pearls, and shewed several which he averred to have been thus obtained.

He, however, disposed of the secret to a merchant at Gothenburgh for the moderate sum of about two hunded guineas, and the heirs of this gentleman again offered it for sale in 1780; from which we may conclude, that however curious it might have been, and interesting to a naturalist, it was not very profitable as a speculation.

It has also been asserted, that pearls are in themselves prolific; and some experiments are even said to have been successfully made on their reproduction and growth. It is, however, quite certain that nothing beyond conjecture has been ascertained on this subject, although the term "seed-pearl" is thought to have arisen from its being the supposed germ of a larger jewel, rather than from its own diminutiveness.

The value always set upon pearls has occasioned various attempts to imitate them. At first it was thought that large pearls might be made from those that were small or broken, and receipts have been published by which it is pretended that object might be effected; but it is impossible to impart to the pulverized substance either the hardness or the

lustre of the original. In the beginning of the sixteenth century the Italians invented hollow glass beads, which were incrusted internally with a pearl-coloured varnish; but the sale was prohibited by government as being fraudulent. Solid beads of coloured glass were then invented, and afterwards, small balls of wax and gum covered with enamel, which last are still occasionally used. At length the most approved mode of imitation, now adopted, and which approaches in appearance very near to nature, was accidentally discovered in the following manner.

A bead manufacturer at Paris happening to remark, that when the small fish which we call the bleak (*cyprynus albernus*) was washed, the water was filled with fine silver-coloured scales, it occurred to him to reduce these into powder, and to employ it as an enamel. The experiment succeeded, and produced all the lustre of the finest oriental pearl; but it was found that, when exposed to heat, it separated from the beads and adhered to the skin. To remedy this inconvenience, and at the suggestion of a lady, hollow glass beads were coated inside, in the

ancient manner already mentioned, with this powder, which obtained the name of essence of pearl; and thus was brought to perfection an elegant invention, of which the following account will give a tolerably accurate idea.

Of a peculiar kind of fine glass, of a blueish tint, slender tubes are formed, which are then blown into small hollow globules; and the better to imitate nature, the artist gives to some of these, small blemishes, like those occasionally seen in real pearls. In order to incrust these, he mixes the essence with melted isinglass, and blows this varnish into each bead with a fine glass pipe, diffusing it equally over the internal surface by immediately placing the bead thus prepared in a vessel suspended over the table at which he works, and which he keeps in constant motion with his foot. To render the beads solid, they are then filled with white wax, and, being perforated with a needle, they are threaded in strings for sale; but the holes are first lined with thin paper to prevent the thread from adhering to the wax.

Four thousand of these little fish will

scarcely produce a pound of scales, from which not more than four ounces of pearl-essence can be obtained; and as this soon becomes putrid, great inconvenience was often occasioned by the necessity of using it immediately. Attempts were made to preserve it in spirits of wine and in brandy, but these corroded the particles, and destroyed their lustre, and it was long before the important discovery for this art was made, that it can be kept without injury in volatile alkali.

The person to whom the ladies are indebted for this invention, was called Jaquin; and his heirs, not long since, perhaps still, continued the business at a considerable manufactory in the *Rue du petit Lion*, at Paris. The date of the discovery is not, however, precisely known: it has been ascribed by some writers to the reign of Henry IV., and by others to the year 1656; that it was practised with success in 1686 we may presume from an anecdote in the *Mercure Gallant* of that year, in which it is said, that a certain French marquis had insinuated himself into the good graces of a young lady by the present of a necklace of pearls valued at 2,000

livres, but which proved on inspection to be false, and had been purchased for three louis.

Other modes of imitation, or improvements on that of Jaquin, are said to have been discovered within these few years in England; but if so, the inventors have not made them public.

BALLOONS.

ORIGIN OF BALLOONS;—MESSRS. MONTGOLFIER, CHARLES AND ROBERT;—FIRST AERIAL VOYAGE;—DESCRIPTION OF THE BALLOON;—PILATRE DE ROSIER;—LUNARDI; BLANCHARD;—SHELDON;—FIRST ASCENT IN ENGLAND; SADLER;—GARNERIN;—THE PARACHUTE.

The idea of rising in the air was familiar to the ancients, as well as to the moderns, and various schemes were at different times devised for effecting that object. But these were all upon mechanical principles, which have been proved incapable of answering any useful purpose, and no attempt at aerostation was made until a Portuguese friar, named Guzman, contrived, about a century ago, to launch a paper bag into the air; which, however, fell, after attaining a very moderate elevation. We have no particulars of this experiment, nor did it lead to any

farther result, and the subject seems to have been dropped until the late Mr. Cavendish's discovery of the specific gravity of inflammable air again brought it into notice. The possibility of raising a bladder filled with this air through the more dense atmospheric air was then suggested by the ingenious Dr. Black, of Edinburgh, and some experiments were tried by Mr. Cavallo; but the honour of having made the first real balloon belongs to Messieurs Stephen and John Montgolfier, natives of France, and in that country the invention was brought to perfection.

On the 5th of June 1783, all the different states of Vivarais were assembled in the small town of Annonay, when they received an invitation from Montgolfier and his brother, proprietors of a large manufactory of paper in that town, to be present at a physical experiment which was to be made on that day. In the public square there was suspended a sack thirty-five feet in height, made of fine paper lined with linen, the numerous folds of which indicated that its interior was hollow, or only contained atmospheric air in equilibrium with the exterior air. But scarcely

was the sack filled by a certain process which the brothers puposely kept secret, than it took the form of a majestic balloon, which swelled gradually, balanced from side to side, and tended to ascend. At length, being freed, it soared above the heads of the spectators, and in less than ten minutes attained the height of more than one thousand fathoms from the earth, when it descended slowly, after having described a space of seven thousand two hundred feet. The experiment was afterwards repeated at Avignon, and a car being attached to the machine, some live animals were sent up in it, and descended without having received any injury.

The ideas of genius are of an astonishing simplicity. By meditating upon the ascension of vapours in the atmosphere, and upon their taking the form of clouds, the secret of raising a machine into the air was discovered to consist in enclosing a fluid, in any light vessel of less weight than the atmospheric air. After some consideration upon the manner of obtaining this fluid, the following method was adopted as being the most simple

and the least expensive. A pan of fire placed under the cavity of the balloon, introduced this fluid lighter than the atmospheric air, or rather diminished the weight of the interior air by rarifying it. It was in this manner that the problem was resolved, but the mode of executing it still remained a secret to all but the inventors.

In the mean time, Mr. Charles, a celebrated physician and professor of experimental philosophy, invented a new and more safe method of ascension. Having filled a globe of thin silk—varnished over with the elastic gum commonly called Indian rubber, dissolved in oil,—with hydrogen gas, or inflammable air, it ascended from the Champ de Mars, in the presence of a multitude of spectators, and descended at about four leagues from Paris.

Shortly after this, Montgolfier and his brother, aided by two brothers named Robert, ingenious mechanics, having constructed an aerian bark that was considered both convenient and safe, the celebrated Pilâtre de Rosier, professor of physic, accompanied by the Marquis d'Arlandes, ascended on the 21st

November 1783, before the Court, at the Château de la Muette, in the Bois de Boulogne, and after having traversed the Seine and Paris, descended slowly at the butte aux Cailles. The voyage was not more than four or five thousand fathoms; but it was sufficient to demonstrate the feasibility of the project, and the intrepidity of the act confers eternal honour on the memory of the daring adventurers. The balloon employed on this memorable occasion was of an oval shape, seventy-four feet in height, and forty-eight in diameter, and was superbly ornamented. It contained a gallery suspended underneath for the accommodation of the aeronauts, in which there was a grate, with a supply of fuel, by means of which the machine might be kept in the air at pleasure: the weight of the whole apparatus was upwards of one thousand six hundred pounds.

On the first of December 1783, Messieurs Charles and the brothers Robert ascended from the garden of the Tuilleries, and after having traversed a space of about nine leagues, descended in safety in the plains of Nesles. The machine in which they ascended

was considerably smaller than that used on the former occasion; and differed from it in this important particular, that it was filled with inflammable air, which, being much lighter than the heated atmospheric air, possessed many advantages over it. This invention, thorefore, superceded the former, and has been adopted, with some improvements, on all subsequent occasions.

On the 23d of January 1784, Prince Charles, son of the Prince de Ligne, Counts Laurençin, Dampierre, and La Porte, the two Montgolfiers, Pilâtre de Rosier, and a celebrated mechanic named Fontaine, ascended together at Lyons, and descended after a voyage of fifteen minutes.

Sometime afterwards, Pilâtre de Rosier, whom we have already mentioned, accompanied by a physician named Romain, ascended at Boulogne-sur-Mer, intending to land in England. A short time after their ascent they were observed busily employed in opening the valve, and evidently anxious to get down; but before they could accomplish their object the balloon took fire, and descended so rapidly, that both the unfortunate

aeronauts were killed. A monumental pillar to their memory marks the scene of the catastrophe.

These were the chief aerial voyages made at that period in France. In England, the first attempt of the kind was made by Vincent Lunardi, an Italian, who ascended on the fifteenth of September 1784, from the artillery ground in London, and descended near Ware, in Hertfordshire. His balloon was formed of oiled silk, and was thirty-five feet in diameter. The gallery was attached by means of a net which was spread over the upper part, and from which cords descended from which it was suspended. The machine had no valve; the inflammable air was introduced through an aperture in the lower extremity, which terminated in the form of a pear, and the gas with which it was filled was produced from zinc by means of vitriolic acid. The first Englishman who ascended in a balloon was Mr. Sheldon, professor of anatomy at the Royal Academy, who accompanied a Frenchman named Blanchard. They rose from Chelsea, and descended, after traversing about fourteen miles, when Mr.

Sheldon was landed, and Blanchard having re-ascended alone, continued his voyage to Rumsey, in Hampshire, being a distance of seventy-five miles from the point of starting.

Mr. Sadler, of Oxford, next ascended from that city, and accomplished a distance of fourteen miles in seventeen minutes. After him, Admiral Sir Edward Vernon, accompanied by Count Zambeccari, went from London to Horsham, in Sussex, in less than an hour.

But the boldest attempt was that of Blanchard and Dr. Jefferies, who actually crossed the straits of Dover on the 7th of January 1785, and landed in safety near Calais. They ascended from the cliff at Dover, on a clear frosty morning, with a favorable, but scarcely perceptible wind. After the balloon was launched, it was found insufficient to support the weight with which it was freighted, and it became necessary to throw out nearly all the ballast; it then ascended slowly, but when about midway across the channel, it began to descend so rapidly that the travellers were under the necessity of throwing out not only the remaining ballast, but every portable

article in the car; and this proving ineffectual, they were even reduced to strip themselves, when at length it again rose, and relieved them from the apprehension of terminating their voyage in the ocean: a danger, we may remark, which was on two subsequent occasions very narrowly escaped by Mr. Crosbie and Major Money; the one attempting to cross the Irish Channel, and the other to traverse the German Ocean.

Blanchard, a few months afterwards, made a third attempt, which is remarkable for being the longest aerial voyage that has yet been accomplished. He ascended at Lisle, and travelled three hundred miles before the balloon descended. About the same time Mr. Baldwin ascended from Chester, and afterwards published a very interesting account of his voyage, which may be found detailed, together with much curious information on the general theory and practice of aerostation, on a work by him entitled aeropedia.

From this period we hear but little of balloons for several years, until another Frenchman, the well-known Garnerin, again

excited public attention to the almost forgotten subject of aerostation. This gentleman made his first ascent at Paris in the year 1798, accompanied by a female, who, we believe, afterwards became his wife, and frequently repeated the hazardous experiment alone. He visited England in the summer of 1802; and, ascending at Ranelagh, alighted at Colchester, a distance of sixty miles, in three quarters of an hour. This voyage is not alone remarkable as having accomplished the greatest distance in the shortest time, but as having established the fact that the real velocity of the wind is much greater than had been commonly imagined.

Intrepid and adventurous as that spirit must have been which first undertook to explore the regions of the atmosphere in a balloon, it remained for M. Garnerin to exceed all his predecessors by the daring boldness of his descent in a *parachute*. This extraordinary experiment was made in London, and the following is the mode in which it was performed:—

The balloon was of oiled silk, of the usual form, and covered with a net, from which

ropes proceeded, which were joined together, a few feet below the under part, in such manner as to form collectively but one rope, from which the parachute was suspended. This machine was in the form of a large canvas umbrella, of thirty feet in diameter, but without ribs, and with a hollow tin tube in lieu of a handle. Several ropes, of about thirty feet in length, were stretched from the edge of the parachute, and terminated in a knot, to which was hung a deep circular basket, in which M. Garnerin placed himself. The single rope which has been described as proceeding from the net that covered the balloon, passed through the tube which formed the handle of the parachute, and was fastened to the basket; so that by cutting this rope the parachute would be separated from the balloon, and in falling down, would be expanded by the resistance of the air. The use of the tube was to prevent the suspending rope from becoming entangled, and to keep the basket at a certain distance from the canvas. The balloon ascended majestically from St. George's Parade, in North Audley Street, and in about eight minutes' time reached to

such an immense height, that although the morning was beautifully clear, the spectators could only just discern the basket; when, at that moment when every eye was contemplating the object, M. Garnerin cut the rope, and the parachute suddenly dropped with a velocity that threatened to precipitate him instantly to the earth. A moment afterwards, however, the canvas expanded; the descent became gentle and gradual, and the aeronaut landed in safety in a field near Pancras. He was confused, and somewhat disordered in the stomach, which was attributed to the extraordinary motion of the parachute, which vibrated in its descent like the pendulum of a clock; and to some strong shocks which the basket received on touching the earth; but he soon recovered his spirits, and his health was unaffected.

BLACK-LEAD.

PLUMBAGO;—LEADEN STYLES;—BLACK-LEAD PENCILS;—MINES OF LEIZERSDORFF AND BORROWDALE;—WAD;—SPANISH AND FRENCH PITS;—CRAYONS;—INDIAN RUBBER.

It would be of some importance, were it possible, to ascertain exactly the period when black-lead was first used, as the antiquity of manuscripts ruled with this substance, or of drawings made with it, might then be determined.

Pencils are here alluded to, formed of that metal called *plumbago* or *molybdæna*, although a distinction has been drawn between these names by modern mineralogists. It has been supposed that the use of this metal is as old as certain manuscripts in which lines, often exhibiting a bright lead colour, may be

clearly distinguished; but this opinion may be easily refuted by observing, that lines drawn with lead itself have so much the appearance of those made with plumbago, that it is sometimes scarcely possible to perceive the difference; and it has been proved that the ancients used a small round plate of lead for ruling lines, which was less liable to cut the parchment than a leaden style. Professor Schönemann has given a description of two manuscripts of the eleventh or twelfth century, preserved in the library of Wolfenbuttel, in one of which the lines are partly drawn with a style, and partly in a light manner with lead; but the lines in the other, he remarks, have evidently been drawn with a black-lead pencil.* Le Moine also makes mention of a document of the year 1387, which, he says, is also ruled with black-lead, and remarks, that the custom of ruling ceased about the years 1421 and 1424.†

But the antiquity of black-lead pencils could be more easily determined were it

* Schönemann, Versuch eines systems der Diplomatik. Hamb. 1802.

† Le Moine, Diplomatique pratique. Metz, 1765.

known what mineralogist first mentioned plumbago and its uses. It is not clear that this mineral was known to the Greeks and Romans, who, however, certainly meant a real lead ore, or some production of lead works, by the term *galæna*. In Horace's time it is more than probable that red chalk or charcoal was generally used in drawing, as he says:—

> " *Velcum Pausiacâ torpes, insane, tabellâ,*
> *Quî peccas minus atque ego, cum Fulvi, Rutubæque,*
> *Aut Placideiani contento poplite miror*
> *Prælia, rubricâ picta aut carbone,*" &c.
>
> Lib. ii. Sat. vii. v. 93-95.

> " If some fam'd piece the painter's art displays,
> Transfix'd you stand, with admiration gaze;
> But is your worship's folly less than mine,
> When I with wonder view some rude design
> In crayons or in charcoal, to invite
> The crowd to see the gladiators fight."
>
> *Francis.*

In a work on fossils written by Conrade Gesner, and printed at Zurich in 1565, mention is made of pencils for writing which had wooden handles, with a piece of lead, or artificial mixture called *stimmi Anglicanum*, and an engraved representation is given of

the instrument, which shews that they must have been then very scarce. Thirty years afterwards Cæsalpinus gave a better description of it, and described it as a lead-coloured shining stone, which communicated an ash-grey tint to the fingers, and which, when pointed, was used by painters and draftsmen. He adds, that it was called Flanders' stone, because brought from the Netherlands to Italy.

Imperati, three years after, described it as a smooth mineral, which appears greasy to the touch, and has a leaden color, which it communicates with a sort of metallic brightness. When capable of being crumbled, it was mixed with a certain clay called *rubrica*, and made into crucibles, which were extremely durable in the fire; when dense and firm, it was manufactured into writing-pencils. Bartholomew Ambrosinus calls it *lapis plumbarius*, but his description of it is borrowed from the two last-mentioned authors. Although the use of black-lead for crucibles was known to Imperati, no mention whatever is made of it by several old mineralogists.

The oldest pits with which we are acquainted are those of Leizersdorff, in Germany, and of

Cumberland, but their antiquity is unknown; it may, however, be conjectured to be very remote from the circumstance that the mineral is there provincially termed *wad* or *wadt*, which in the ancient Saxon signifies black. The mines, which furnish the best plumbago, are situated on the Borrowdale mountains, about ten miles from Keswick, and, according to a regulation among the proprietors, they are opened but once in seven years, when, in order to keep up the price of the mineral, only a certain quantity is extracted.

Pettus remarked, in a work entitled the Laws of Nature and Art, published in 1683, that pencils made from it were enclosed in fir or cedar; and Robinson says, in his History of Westmorland and Cumberland, that the country people near Keswick at first used it for marking their sheep, until the art was discovered of employing it for earthen ware, and for preserving iron from rust. The greater part of the plumbago used in commerce comes from Spain, but it is only fit for coarse ink. It is found in the neighbourhood of Ronda, a town in Granada; but the time when the pits were first opened is un-

known. The mineral has also been discovered in France, near Curban, in Upper Provence.

The use of plumbago was probably first introduced into Italy in the sixteenth century, and employed in drawing: The pencil first used in that country was composed of two parts of lead and one of tin, fused together, and was called a *style.* The use of red and black chalk is of earlier origin; but no mention of our plumbago is made in the works of the old Italian artists, where it would be as likely to find it, as in treatises on mineralogy.

It is worthy of remark, that the method of effacing the marks of black lead with Indian-rubber was first discovered in England.

BOLOGNIAN STONE.

DESCRIPTION AND PROPERTIES; — MODE OF PREPARATION ;—EFFECT ;—DISCOVERY ;—FIRE-STONE.

THE fossil commonly known as the Bolognian stone is chiefly found on the hills in the neighbourhood of Bologna, and sometimes in the vicinity of Rimini. It appears luminous in the dark; and this property has occasioned much learned research, which, however, has been attended with little other effect than that of showing that our theory of light is imperfect, aud that many of the hypotheses upon which it is founded are, at least doubtful, if not altogether false.

This species of stone is usually discovered in a marly soil, in single pieces, of a somewhat conical form and uneven surface, and about two or three inches in diameter; its

structure is foliaceous, the colour a semi-transparent white, and it is both hard and extremely heavy. With the exception of its weight and hardness, it bears a near resemblance to that class of gypseous spars called selenites, and has, on that account, been termed, by some mineralogists, *selenites globosus;* but this appellation does not appear to have been adopted in any modern system.

In order to produce the luminous appearance, those pieces are selected which are the purest, the heaviest, and the most laminated: they are then made red-hot, pounded, and reduced to a powder, which is afterwards converted into a paste by means of a solution of gum-tragacanth; and of this small cakes are formed of about an inch in diameter and two lines in thickness. These, being first dried in a stove, are again laid on the fire until they become ignited, after which they are suffered to cool, and are carefully guarded from the air and damp. When one of these cakes is produced, for a few minutes only, to the light, and then suddenly withdrawn into a dark place, it appears to shine like a burn-

ing coal; and as it does not exhibit any unusual appearance unless it has been thus exposed, it therefore seems that it must attract the light which it afterwards emits. In process of time this power becomes weakened, and is eventually entirely lost, but may be restored by again subjecting the cake to the operation of fire.

The discovery of this phenomenon took place early in the seventeenth century; and the Italian authors who first noticed it have concurred in ascribing it to one Vincent Cascariolo, a shoemaker of Bologna. This man, who it seems, like many others of that day, dabbled in the science of alchymy, accidentally hit upon it in some of his experiments, and produced it among the initiated, as a mysterious agent in the transmutation of metals, under the imposing name of the sunstone. Notwithstanding the fallacy of any expectation of advantage from it in this way was soon ascertained, the Italian chemists long affected to keep the mode of its preparation a profound secret; and in the "Philosophical Transactions" for the year 1666, it

was mentioned, that the last possessor of the art had died without communicating it. Whatever truth there may have been in this assertion, it certainly was again known towards the close of the same century; and a German chemist of the name of Marggraf not only explained the most accurate process of preparing it, but also discovered that similar luminous stones may be composed of the weighty spars and sparry fluors. It has, indeed, been demonstrated that a mixture of calcined oyster-shells combined with flour of sulphur, will produce the same effect, only that the light emitted, instead of being of a fiery red, is white.

It is worthy of remark that, in De Thou's history of his own times,—a work which, although occasionally bordering on the marvellous, is yet too well confirmed to be altogether discredited—it is mentioned, that, in the year 1550, when Henry II. of France, made his solemn entry into Boulogne, upon its restoration by the English, a fire-stone, said to have been brought from India, was presented to him by a stranger, in a foreign

habit. De Thou, indeed, says that it not only seemed to burn with inconceivable splendor, but that it actually could not be touched without danger; and, what is still more astonishing, that it would not bear confinement, nor could the art of man secure it within a narrow space, but if closely covered, it suddenly sprung with force into the air.

CHEMICAL NAMES OF METALS.

PRIMITIVE NAMES; — ASTROLOGY; — INFLUENCE OF THE PLANETS; — ASTROLOGICAL NOMENCLATURE; — ANECDOTE OF POPE INNOCENT III.; — SYMBOLICAL CHARACTERS.

As those metals which were first known received the same names as some of the heavenly bodies, it may be asked whether the planets were named after the metals, or the metals after the planets? But it is beyond doubt that the present names were first given to the planets, and afterwards to metals; and also that the Romans borrowed them from the Greeks, and transmitted them at a later period to us. The worship of the sun, as a god, by several rude and barbarous nations, gave rise to the idea that each planet was either a divinity, or the residence of a god,

and their folly, in course of time, led them to ascribe the same attributes to the celestial bodies as were generally allowed, in the fictions of their mythologists, to the gods after whom they were named.

The most ancient trace of this division of metals is to be found in the religious worship of the Persians, who held every thing as sacred which amounted to the number seven, on account of the deified planets being of that number. This, in the course of time, laid the foundation of astrology; and hence the planet Mars was supposed to influence war, while Venus excited the softer emotions of love. Thus they named the seven first discovered metals after the seven planets, each of which, according to their opinion, led in its revolution to a gate of the same materials, and represented lead by Saturn on account of its slow motion; tin by Venus, which resembled its lustre and brightness; copper by Jupiter; iron by Mercury, on account of its strength and fitness for trade; a mixed metal by Mars; silver by the moon; and gold by the sun. Such is the opinion advanced by Origen, in his refutation of Celsus (who as-

serted that the seven heavens of the Christians, and the ladder which Jacob saw in his dream, had been borrowed from the mysteries of Mithras. But it is probable that the transcribers of the former have transposed the names of the gods, for, according to the present system, tin belongs to Jupiter, copper to Venus, iron to Mars, and the mixed metal to Mercury. In this manner the powers and properties of some divinity were ascribed to the metal which bore its name, and thence arose many of the absurd conceits which abound in the writings of the ancient alchymists.

This astrological nomenclature appears to have been known to the Indian brachmans, for, we are informed that a brachman sent seven rings to Apollonius, distinguished by the names of the seven planets, one of which he was to wear every day according to the day of the week; therefore, it is most probable that he was to wear the gold ring on Sunday, the silver one on Monday, the iron one on Tuesday, and so on. The Egyptians dedicated copper or brass to Venus; tin to Mercury; and *electrum* to Jupiter: which last was a mixture of gold and silver, and

was perhaps, on this account, considered as a distinct metal, because, at that time, men were unacquainted with the art of separating minerals. Mystical properties have indeed been attributed to precious stones as well as metals, and our readers will no doubt recollect the well-known anecdote of Pope Innocent III., who sent to our King John a present of four rings set with different coloured jewels; begging him, at the same time, to consider seriously their form, number, matter, and colour. The form, being round, shadowed out eternity, for which it was his duty to prepare: the number denoted the four cardinal virtues, which it was his duty to practise: the matter, being gold, the most precious of metals, designated wisdom, the most precious of accomplishments, which it was his duty to acquire: and as to the colour, the green of the emerald represented faith; the blue of the sapphire, hope; the redness of the ruby, charity; and the splendid yellow of the topaz, good works.

The characters by which these metals or planets are expressed, although bearing no affinity whatever to them, shew, nevertheless,

how easily the mind may be brought to conceive a connexion between them.

The circle was ever considered, among the Egyptians, to be a symbol of the sun; the semicircle, in like manner, was supposed to represent the moon; the character ♄ designated the scythe of Saturn; ♃ the thunderbolts of Jupiter; ♂ the lance and shield of Mars; ♀ the looking-glass of Venus, an ☿ the caduceus of Mercury.

Among all the characters adopted by chemists, that assigned to gold alone agrees with the above mythological representation. Gold was considered by them to be the most perfect of all metals; silver, which ranked next in their estimation, was designated by a semicircle marked double.

All other metals were distinguished by characters composed of those which represent gold and silver, according as they partook more or less of the nature of these two metals. Gold, with a silver color, is discovered in the character ☿. The cross at the bottom expresses some substance without which quicksilver would be gold or silver; and which is also combined with copper, the

possible transformation of which into gold is expressed by the character ♀. The character ♂ bears also an affinity to gold, although the half-cross is written in a more concealed manner; for the upright line should merely touch the horizontal without intersecting it. Tin is composed of one half silver, and one half of the unknown metal, and is thus expressed, ♃. The same unknown metal is predominant in lead, and a similitude to silver is remarked in it, for which reason the character ♄ is assigned to it.

The chemical signification of these characters may be traced to a much earlier period than the Heathen mythology. Some pretend they may be found in the table of Isis, and bring them forward as a proof of the great antiquity of chemistry. In the oldest manuscripts, Mars is represented by the letter Θ with a ς placed above it, and stands for the word Θουρος. The letter Z formerly designated Ζευς or Jupiter, but afterwards a ς was placed at bottom to render it more distinct. The supposed looking-glass of Venus is nothing more than the initial letter, somewhat distorted, of the word Φωσφορος, by which name

she was known. The scythe of Saturn has been formed from the two first letters of his name, Κρονος. The initial letter of the Greek word Στιλϐων, the name for Mercury, was formerly written C; and, to mark the abbreviation still more, it has been written ν, which, with the addition of the next letter τ, will nearly form the character ☿.

The present characters, according to Scaliger, must be of very ancient standing, as he says they are found upon many old gems and rings; but their antiquity has not been exactly ascertained.

COBALT.

DESCRIPTION ;—ZAFFER ;—SMALT ;—USES ;—DISCOVERY ;—EGYPTIAN STAINED GLASS ;—CHINESE PORCELAIN ;—LAPIS LAZULI ;—ORIGIN OF THE TERM COBALT ;—INVENTION OF PAINT PREPARED FROM COBALT.

THE name of Cobalt is at present given to those minerals which contain that semi-metal, the calx of which may be melted into blue-glass, and which turns common glass of a blue colour. This calx is the only part which is used. The cobalt being first washed and freed from the common mineral bodies, especially bismuth and arsenic, which it contains, is afterwards well calcined, and sometimes mixed with fine sand; it is sold under the name of zaffer (*zaffera*). Sometimes it is mixed with silicious earth and potashes, and melted to a kind of blue glass, which, when ground very fine, is technically called

smalts, but is commonly known by the name of powder-blue. These articles are chiefly employed in tinging crystal, enamelling, for imitating opake and transparent precious stones, and painting and varnishing real porcelain and earthen and potters' ware: the cheaper kind is employed in washing linen.

The modern method of preparing cobalt and smalt was undoubtedly invented about the end of the fifteenth or the beginning of the sixteenth century, but whether the ancients were acquainted with cobalt, and used it for colouring glass, is not certain. They opened and worked mines in different places, and made blue glass and enamel, probably from cobalt; but when this mineral failed, this art was perhaps lost for a time, as was that of preparing Corinthian brass. As no species of metal is more various and changeable in its appearance than cobalt, it is difficult to say whether the ancients were really acquainted with it, especially as their term *cadmia* has been applied to several things by different authors, and the use of cobalt does not necessarily imply a knowledge of the metal; thus the moderns made brass for cen-

turies before they were acquainted with the preparation of zinc: besides, bismuth and arsenic, which are great component parts of cobalt, would certainly have been sooner known than they were, had the ancients prepared smalt and cobalt for colouring. It has also been ascertained by chemical experiments on blue tiles found in a Roman tesselated pavement, that the enamel showed not the least trace of cobalt; and as it is possible to impart a blue tint to glass and porcelain by means of iron, it is not improbable that the ancients may have made use of it for obtaining this colour.

On the other hand, as mention has been made, at a very early period, of glass stained blue by the Egyptians, and of the Chinese porcelain which was likewise of a blue colour, we must admit that these people either used ultra-marine or cobalt. A blue is likewise seen on mummies, which, for many centuries, preserves all its beauty. Mention has also been made of a mine of *azur*, in China, probably the *lapis lazuli*, which used formerly to be used for colouring porcelain; but

smalt is now sent in large quantities from Europe to China for that purpose.

Cobalt appears to have been dug up in considerable quantities about the end of the fifteenth century from the mines on the borders of Saxony and Bohemia. As it was not at first known to what use it could be applied, the miners threw it away as valueless. It appears, indeed, that the term cobalt took its rise from the supposed worthlessness of the mineral, and was derived from *Cobalus*, which was the name of a spirit that was said to haunt the mines and destroy the labours of the miners.

The invention of paint prepared from cobalt, is, according to the best accounts, ascribed to the middle of the sixteenth century, and was discovered by accident by Christopher Schurer, a glass-maker at Platten. Being once at Schneeberg, he collected some beautiful coloured pieces of cobalt, and, having found that they were capable of fusion, mixed some of it with his preparation for making glass, and thus obtained fine blue glass, which, being afterwards ground, was

used as a pigment by potters and painters on glass. At first it was prepared merely for the potters, but, in course of time, became an article of commerce, first with Nuremberg, and afterwards with Holland. Schurer was persuaded by the Dutch to remove to Magdeburg: but he returned to his former residence after some time, and constructed first a hand-mill, and afterwards one driven by water for grinding his glass. Eight colour-mills were constructed in Holland soon after, and the Dutch in a short time excelled in the art of preparing and grinding glass for paint; insomuch that John George, the Elector of Saxony, sent for two colour-makers from Holland, and gave one thousand florins towards enabling them to improve the art. Several other mills were erected in a short time in different parts of Germany, but, from various authorities, it is generally believed that the Dutch constructed the first mills, and were in possession of the secret of making stained glass with cobalt, as early as the beginning of the sixteenth century. Large quantities of this article are imported into England from Germany, for the use of the

manufactures, under the different names of zaffer and smalt, according to the mode of preparation, and it is only of late years that efforts have been made to prepare it in this country. An ingenious manufacturer in Yorkshire, who first made the attempt, was ruined by the Excise, which seized upon his stock under the pretext that it was glass, and as such subject to duty; and although it was satisfactorily proved that it was intended to be calcined, and it was admitted by the officers of the crown that the seizure was illegal, yet no redress could be obtained, and the unfortunate man died of a broken heart without being able to perfect the operation.

COLOURED-GLASS.

ANTIQUITY OF COLOURED GLASS;—ANECDOTE OF THE EMPEROR GALLIENUS;—ANCIENT STAINED GLASS;—ARTIFICIAL RUBIES;—OLD CHEMISTS: CASSIUS; LIBAVIUS; KÜNKEL;—PAINTING ON GLASS;—ENAMEL;—MOSAIC WORK.

In all probability the art of making glass and that of colouring it, were discovered nearly about the same time; for, if the substance of which glass is formed contain any metallic particles, it will always assume some tint or other, so that the idea of giving it the tinge of some precious stone, was not difficult to be conceived. Proofs are not wanting to shew that this art was carried on to a great extent among the ancients, as Pliny makes mention, among others, of artificial hyacinths, sapphires, and of that black glass

which so nearly resembled the peculiar stone discovered in Ethiopia by Obsidius, and thence termed Obsidian. As a proof that it was, at a very early period, used for the purposes of deception, we are told by Trebellius Pollio that the Emperor Galienus, in order to punish a cheat who had sold his wife a piece of coloured glass for a jewel, ordered him to be carried away to the lions' den, and, when there, desired that a hen should be let loose upon him; after which joke, a crier proclaimed this to be the punishment of his roguery. It would appear also that Alexandria was not alone famous for its glass-houses, and for the skill and ingenuity of its workmen, but also for the art of imparting vivid colours to the substance; for it is related of the Emperor Adrian, that he placed such value on some coloured glass cups, which he had received from an Egyptian priest, as to order them to be only used on festivals.

In some collections of antiquities at Rome, pieces of coloured glass are to be seen which were once used as jewels. In the Museum Victorium, a chrysolite and an emerald are shewn, both of which are quite transparent

and coloured throughout, and neither have the smallest blemish, either externally or internally; which is not to be accomplished without great care and skill, and which proves that the art had attained to considerable perfection at a very early period.

The materials used by the ancients for colouring glass, have not been described by any writer; but it is certain that metallic calces can alone be employed for that purpose, because these pigments withstand the heat of the furnaces. Ferruginous earth was, most probably, the principal substance used in giving to glass, not only all shades of red, violet, and yellow, but likewise of blue; at present, sometimes an artificial and sometimes a natural iron ochre is employed, in common works, for the same purpose.

In the last century, some German artists discovered the method of making artificial rubies with gold, instead of iron; and these when well set, defied detection, unless tried by a diamond or file. This substance, which must be mixed with the best frit, is called the precipitate, or gold calx of Cassius, also gold purple, or mineral purple.

This Cassius, from whom it takes its name, was called Andrew, as was also his son, which has caused them sometimes to be confounded together; the father was secretary to the Duke of Schleswig, and is not known by his writings; the son took the degree of Doctor, at Leyden, in 1632, practised physic at Hamburgh, and was physician to the Bishop of Lubec; he was also the inventor or preparer of the gold purple, and of a bezoar essence, and the author of a treatise on the properties of gold, illustrated by some curious experiments.

Old chemists probably meant some preparation of this kind, when they talked in the mystic language used by them at that day, of red lions, the purple soul of gold, and the golden mantle; but the allusions of these metaphors are now unknown.

When Libavius published his alchymy in 1606, this manner of making ruby-glass must have been a secret, as he quotes an old receipt for making them, and merely conjectures that they may be made of gold as they are found near gold mines, and probably imbibe the color of that metal; which opi-

nion has not been acceded to by later chemists, particularly by Achard, who found more iron than gold in that precious stone. The conjecture of Libavius, though deduced from false principles, has nevertheless been confirmed by experience.

In the 17th century, the preparation and use of gold purple was brought to great perfection by John Künkel, who afterwards, being ennobled by Charles XI. of Sweden, took the name of Löwenstiern. He made great numbers of artificial rubies, and sold them at a high price by weight. He himself says, he made a cup of ruby glass weighing twenty-four pounds, and full an inch in thickness, of a beautiful color throughout, for the Elector of Cologne. He was afterwards, in the year 1679, appointed inspector of the glass-houses at Potsdam, by Frederic William, Elector of Brandenburgh, who at the same time gave 1,600 ducats to perfect them. A cup with a cover of this manufacture is still preserved at Berlin.

We may almost reckon painting on glass, and in enamel, and the preparation of coloured materials for mosaic work, as branches

of the art of colouring glass; and in all these, a fine red is the most difficult to obtain. The old master-pieces of painting on glass are always found to have a transparent red varnish burnt into them on one side, or, when stained through and through, the panes are thinner than those coloured in the other manner. In all likelihood, therefore, the old artists used iron or manganese, which pigment soon becomes, when greatly heated, blackish and muddy. A red colour in mosaic work is obtained with less difficulty, as opacity, rather than transparency, is required. Those pieces which shine like the finest sealing-wax, are most valued at Rome, where they were at one time, made, from a kind of copper dross, and only by a man named Mathioti; at present several artists in that city prepare these materials, but are unable to give them a perfect high colour.

DYEING.

ANTIQUITY OF THE ART;—INGENUITY OF THE ANCIENT DYERS; — TAPESTRY; — BABYLONIAN PURPLE; — DYED CLOTH OF MEXICO AND OTAHEITE;—THEORY OF DYEING.

Dyeing is the art of fixing certain colouring materials permanently and with uniformity into the fibres of wool, linen, cotton, silk, and other fibrous or filamentous substances. Few arts can lay claim to greater antiquity, and still fewer attained, in ancient times, so great a degree of perfection. It certainly preceded painting, and appears to have been known in the earliest ages of the Jews, Babylonians, and Egyptians, who selected and applied colours for stuffs, cotton, linen, and silk, with the greatest judgment and dexterity. These were extracted from the animal, vegetable and mineral kingdom; and, without confining themselves to cloth or

silk, they dyed equally well leather, ivory, tortoise-shell, the hair of animals, wood, earth, wax, and even imparted a permanent colour to marble.

However, no sooner had the art of painting been carried to some degree of perfection, and the mere outline been filled up by the crayon, and enriched by the natural colours of the object intended to be delineated, than the art of dyeing was united to that of painting, and the needle was full as much employed upon colours as the pencil. According to Pliny, coloured embroidery and tapestry, were known to be of high antiquity among the Jews and Babylonians, but both these arts pre-suppose the existence of outlines, for the artist must have drawn from a pattern. It is possible that the story of Pandion, king of Athens, and of his daughter Philomela, who informed Progne of her misfortunes by describing them on tapestry, may be fabulous; but, be this as it may, the fable, we know, is of remote origin, and, according to Apollodorus, was probably the invention of one of the Cyclic poets. This admirable mythologist says, that Philomela did not paint her

history, but embroidered it, in characters, on a veil. Still, at the period when this fable was invented, embroidery can scarcely be conceived to have been confined to the exhibition of characters alone, and was unquestionably used more freely in the art of tracing and designing. In the time of Homer, we have undoubted proof of the application of tapestry to the delineation of historical subjects. In the third book of the Iliad, Iris finds Helen occupied in representing in embroidery the evils sustained on her account by the Greeks and the Trojans; and Andromache, when informed of the death of Hector, was employed in depicting flowers of various colours on tapestry:—

> "Αλλ' ηγ' ιστον υφαινε μυχω δομου υψηλοιο
> Διπλακα, μαρμαρεην, ενδε θρονα ποικιλλ' επασσε.."

> "Far in the close recesses of the dome,
> Pensive she plied the melancholy loom;
> A growing work employed her secret views,
> Spotted diverse with intermingled hues."
>
> *Pope.*

Lucretius likewise says:—

> "*Quam Babylonica, magnifico splendore, rigantur.*"
>
> Lib. iv. l. 1023.

> "Wetting the rich and Babylonian dye."

The antiquity of the art of dyeing may be still farther authenticated by the perfection to which this art has been carried immemorially in Hindoostan, China, and Ceylon; and likewise by the coloured and figured cloths found, not only in Mexico, but even in the island of Otaheite, on their discovery. Perhaps the circumstance of their being found in Otaheite is the one most in point: for there, unquestionably, the web and woof were dyed previous to their being woven; whereas, in the former place, the cloths, skins, and barks, were generally painted on, rather than imbued with the colouring materials. Yet the art was carried to astonishing perfection by the Mexicans, either by dyeing or painting, at the period when their country was discovered by the Europeans. We are informed that, on the arrival of the Spanish squadron, exact representations of the ships, painted on cloth, were immediately sent to Montezuma; and this was the method they employed for keeping their records, histories, and calendars. From the specimens of Mexican hieroglyphics preserved in the Bodleian library, their materials for colour-

ing appear to have been chiefly obtained from the mineral kingdom, and to have consisted of earths rather than animal or vegetable substances.

The objects usually dyed are either of animal or vegetable origin. Among the former may be classed wool, silk, hair, leather, and skin of every description; to the latter belong cotton, flax, and hemp. There is an essential difference between the affinity for colouring matter possessed by these substances, so that the process for dyeing wool, for instance, may have no effect upon cotton; nor is there any accordance in the quantity of colouring ingredient necessary to dye each stuff. This has been proved by a simple experiment, in which a piece of cloth was woven, of which the warp was wool, and the woof cotton; this was fulled, in order that each substance might undergo the same preparation, aud then dipped in a scarlet vat. The wool alone took the colour; the cotton, when rinsed, remained white. Silk has been found to take twice as much cochineal to dye it as wool. The different force of affinity between different fibres and colouring-matter

is likewise shewn by the more or less perfect manner in which they exhaust a coloured bath; thus wool dyed in a weak solution of sulphate of Indigo, entirely absorbs the dye, and leaves the solution colourless, whereas silk only partially takes the colouring matter from the sulphuric acid. Wool is, generally speaking, more susceptible of taking and retaining the colour than any other substance; silk and other animal matters follow; next to them cotton, and lastly hemp and flax; but this opinion is to be taken in the greatest latitude, nor do those substances which take colour the easiest always retain it the longest.

EAU-DE-LUCE.

COMPOSITION;—PROPERTIES;—LUCE;—DU BALEN.

The pungent essence known by the name of Eau-de-Luce, is, in fact, when properly made, a fluid volatile soap of an agreeable odour, which, instead of the fixed alkali and tallow, of which common soap is made, is composed of caustic volatile alkali and highly purified oil of amber. It is of a milky colour, which it retains if good, but loses it when adulterated, as often is the case, with spirit of sal ammoniac. In its quality of soap it is employed to extract stains from cloth, which cannot be removed by common soap. As a medicine, it is administered, mixed with water, for many diseases and accidents, among others as an antidote to the bite of

some snakes; and it acts as a powerful stimulant when applied to the nostrils in cases of fainting.

The process of compounding this volatile essence requires operations that were long secret, and the chemists, in their researches for the true method, have given various receipts for preparing it: some assert that it can be made perfectly bright without injury to its colour; and among these was an apothecary at Lisle, called Luce, from whom it is said to derive its name; but the blue tint which he imparted to it, and which at one time brought it into great notice, was derived from copper.

The first mention that is made of Eau-de-Luce in medical treatises occurs in the *Recueil périodique d'Observations de Médecine*,* in which it is said to have been made in the year 1742. The inventor is not certainly known; but the French writers ascribe the discovery to a Parisian apothecary named Du Balen.

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* "*Recueil, &c.*" Vol. v. p. 224, ed. 1756.

FULMINATING POWDER.

DETONATING BALLS;—AURUM FULMINANS;—PROPERTIES;—INVENTION;—BASIL VALENTIN;—ANCIENT COMPOSITION OF DETONATING GOLD;—MODERN RECEIPTS FOR DETONATING GOLD AND SILVER;—FULMINATING MERCURY.

THE preparation which a few years since obtained so much celebrity in London under the name of detonating balls, is known to chymists by the various appellations of *pulvis pyrius aureus*, *aurum volatile*, and more commonly *aurum fulminans;* and these names have given rise to a very general supposition, that it is chiefly, if not entirely, composed of gold: it is, however, produced from either gold or silver, and forms a powder which, when heated, or merely crushed, explodes with a tremendous report. The strength and

violence of this substance are truly terrific, and have occasioned many serious accidents to incautious persons; but it, notwithstanding, can never be employed as a substitute for gunpowder, even were the value of the metals from which it is extracted not a consideration, because the explosion does not take place while it is confined. It has, as yet, been considered merely as an object of curiosity, but it is still not improbable that it contains virtues with which we are unacquainted; it is said that it may be employed to advantage in enamel painting, and it has lately been applied to an ingenious improvement in the locks of fire-arms.*

The origin of this invention is lost in the obscurity of the writings of the ancient alchymists, whose wild speculations and unproductive experiments are, for the most part, detailed in an unintelligible jargon, which often served to give an air of mysterious importance to discoveries of little value. It seems probable, however, that it was in-

* See the art. "*Fire Arms*," B. iii. for an account of this improvement.

vented by Basil Valentin, a German Benedictine monk, who lived early in the fifteenth century. There is, indeed, reason to suppose that Valentin made many important observations respecting the properties of gold; but such is the care he has taken to veil them, that they are almost as unintelligible as the Egyptian hieroglyphics, until some supposed new discovery has been made, which is afterwards found among his works, in a passage which no one could previously understand. His writings are, therefore, of about the same utility as were the answers of the ancient oracles, the meaning of which could not be comprehended while they could be of use, and which seldom served any other purpose than to mislead those who attempted to interpret them, before the occurrence of the event to which they referred rendered all explanation unnecessary. But the account which he has given of this detonating gold is so unusually clear, that it would almost seem that he was not aware of the precision with which he had written. As the work in which it is to be found—entitled his last testa-

ment—is scarce, a literal translation of the receipt may not be uninteresting.

"Take a pound of good *aqua-regis* made with sal ammoniac, I mean a pound of good strong aqua-fortis, and dissolve therein eight loths of sal ammoniac, by which means you will obtain a strong aqua-regis, and distil and rectify it until no more *fæces* remain at the bottom, and that it be quite clear and transparent. Then take fine gold-leaf which had been prepared with antimony, pour the aqua-regis over it, and let so much gold be dissolved as it will take effect upon. When the gold is all dissolved, pour into it a little *oleum tartari*, or *sal tartari* dissolved in water, and it will begin to effervesce strongly; when it has effervesced, pour some of the oil again into it, and repeat this until all the dissolved gold fall to the bottom, and the aqua-regis is quite pure and clear. When that is effected, pour the aqua-regis from the gold calx, and wash it carefully in pure water eight, ten, or even twelve times. Then, when the gold calx has well settled, pour the water off, and dry the gold calx in the open air, but not in the sunshine, nor yet over the fire, for so soon as this powder is exposed to a very small degree of heat, it explodes with great violence, and does much mischief, as its force is such that no one can withstand it."

From an addition to this receipt, which it would be superfluous to transcribe, it appears that Valentin had also discovered, that this powder could be again deprived of its force by boiling it during four-and-twenty

hours in strong distilled vinegar; and, in some other parts of his writings, he says that the same effect may be produced by sulphur.

The modern receipts for the composition of fulminating powders, are as follows:—

Gold.—Dissolve pure gold in nitro-muriatic acid to saturation, and dilute the solution with three times its quantity of distilled water, adding gradually some pure ammonia. A yellow precipitate will thus be obtained which must be repeatedly washed with distilled water, and dried on a chalk-stone or in a filter.

Silver.—Dissolve fine silver in pale nitric acid, and precipitate the solution by lime-water; decant the fluid, mix the precipitate with liquid ammonia, and stir it till it assumes a black colour; then draw off the remaining fluid, and leave it in the open air to dry.

The effects of the latter product are much more violent than of that obtained from gold. It explodes by the mere touch: its preparation is so hazardous, that it should never be attempted without a mask with strong glass before the eyes; and no more than a single grain should at any time be tried as an experiment. There is, however, another preparation of detonating silver, less dangerous than the one just mentioned, and which does

not explode without a slight friction, in contact with combustible bodies.

Besides these, a fulminating powder is produced by a preparation of mercury mixed with sulphur; and it is known that mercury, and most, if not all its oxyds, may, by treatment with nitric acid and alcohol, be converted into a whitish crystallized powder, possessing all the inflammable properties of gunpowder, together with many peculiar to itself.

GREEK FIRE.

PERIOD OF INVENTION; — COMPOSITION; — USE; — FIRE-SHIPS; — FIRE-ENGINES.

It is a commonly received opinion, that the inflammable substance which bore the name of "Greek fire" was employed by the ancient Greeks, and that the mode of preparing it was lost at a remote period of modern history. It was not, however, invented until about the year 678 of the Christian æra, when it was discovered by Callinicus, an architect of Heliopolis—which city was afterwards called Balbec—and its use was not discontinued in the East until towards the close of the thirteenth century. Various conjectures have been formed respecting its composition, and some prescriptions have been preserved in ancient historians; among which the oldest, and per-

haps the most to be relied on, is that mentioned by the Princess Anna Comnena, in which the component parts are said to be resin, sulphur, and oil. It has not, however, been found possible to produce a substance from these ingredients similar in its effects to those recorded of the Greek fire, and all that has been ascertained on the subject merely tends to prove that it was a liquid.

The chief purpose for which this extraordinary fire was employed, was to annoy the enemy in naval engagements; for which purpose it was thrown from large engines, or sometimes, as it appears, blown through tubes. Fire-ships were also prepared with it, and introduced among a hostile fleet, and occasionally jars were filled with it, and cast on board the hostile vessel by means of projectile machines. Joinville alludes to the latter, in his history of St. Louis, wherein he mentions, "*ung engin qu'ils appellaient la Parriere, par lequel ils nous gettoient le feu Gregois à planté.*" They were made of metal, painted and gilt, with the extremity resembling the open jaws of some animal, and were usually placed on the prow of the

ship, to which they formed an ornament. These machines are called, by ancient writers, spouting engines, and it seems that they projected the fire to a considerable distance. It is mentioned by John Cameniata, when speaking of the siege of his native city, Thessalonica, which was taken by the Saracens in 904, that the enemy threw fire into the wooden works of the besieged, by means of tubes and other vessels; and the Emperor Leo, who about the same time wrote his treatise on the art of war, recommends such engines to be constructed on the forecastle of ships. Εχετω δε παντως τον σιφωνα κατα την πρωραν εμπροσθεν χαλκῳ εμφιεσμενον, ως εθος, δι ὁυ το τοκευασμενον πυρ κατα των εναντιων ακοντισει. *Tactica*, cap. xix.

GUNPOWDER.

OLDEST ACCOUNT OF GUNPOWDER;—FRIAR BACON;—MANUSCRIPT OF MARCUS GRÆCUS;—ALBERTUS MAGNUS;—ANTIQUITY OF THE INVENTION.

It has been commonly supposed, that the oldest information of which we are in possession respecting gunpowder is to be found in the works of Friar Bacon,* who died in the year 1294, and he is, accordingly, generally considered as the inventor. He, however, only alludes to it so far as to say, that from saltpetre and *other ingredients*, a fire may be made that shall burn at any distance; and it has been conjectured, from an anagram under which the secret is supposed to be enveloped, that these "other ingredients" were charcoal and sulphur.

* "*Bacon.*" De secretis operibus artis et naturæ, et de nullitate magiæ, cap. 6.

There is, however, a manuscript preserved in the Royal Library, at Paris, written by one Marcus Græcus,* who is, by some, supposed to have lived in the ninth, and by others in the thirteenth century, which professes to give an account of a combustible for the annoyance of the enemy, and in which there is a passage from which that in Bacon's works is evidently taken. The same recipe has also been copied by the celebrated Dominican monk, Albertus Magnus,† who died in 1280, and whose reputation for learning was as great, in Germany, as that of Roger Bacon in England. The manuscript of Marcus Græcus is supposed to allude only to the Greek-fire, but it is worthy of remark, that he repeatedly mentions saltpetre, which is not even alluded to in any of the ancient receipts for the composition of that combustible.

Although we may admit that Bacon was in possession of the secret of the composition

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* "*Marcus Græcus.*" Liber ignium ad comburendos hostes; Auctore Marco Græco: published at Paris, 1804.

† "*Albertus.*" De mirabilibus mundi.

of gunpowder, it yet seems probable that the invention took place even prior to the earliest period assigned to the manuscript of Marcus Græcus, and that the knowledge of it was obtained in Europe through the Saracens. The Chinese claim acquaintance with it from the remotest æra of their history; the use of it in war is forbidden in the Veidam, the ancient sacred institutes of the Hindoos; and it is supposed to have been employed in the battle fought near Mecca in the year 690. In support of this surmise it may also be observed, that in no country could saltpetre, and the various purposes to which it may be applied, be more easily discovered than in India, where the soil is so rich in nitrous particles, that little more is necessary than to lixiviate it in order to obtain saltpetre; and where, in fact, this substance is produced in such abundance, that from it is made almost all the gunpowder that is used in Europe.

HUNGARY WATER.

COMPOSITION;—ORIGIN OF THE NAME;—INVENTION;—RECEIPT.

HUNGARY WATER, so long celebrated for its medicinal qualities, is nothing more than spirit of wine distilled upon rosemary; whatever virtues it possesses, independent of the spirit, must therefore be entirely attributed to the qualities of that plant. In order to extract these effectually, the herbs should be quite fresh, and the spirit be not only strong, but the distillation should be frequently repeated. This process is, however, too expensive to allow of the essence being disposed of at the moderate price for which it is commonly sold; the greater part, therefore, of what is usually found in the perfumers' shops, is merely common uncoloured brandy, flavoured with a few drops of the essential

oil of rosemary. The chief place of its manufacture is Montpellier, and other towns in Languedoc, in which province rosemary is produced in great perfection; but it is also made in this country.

The original name "*Eau de la Reine d'Hongrie,*" would seem to imply that it was a Hungarian invention; and accordingly we find that it was first made known by Elizabeth the widow of Robert, King of Hungary, so early as the fourteenth century. This lady, it appears, although then more than seventy years of age, was not only cured of the gout, and restored from a state of debility to perfect health by the use of this water, but became so brisk and handsome, that, as she herself tells us, a king of Poland, whose own age, however, is not mentioned, actually fell in love with her! Upon this Professor Beckmann gravely remarks that, in his opinion, she must have been either inordinately vain, or else in her dotage; but the world affords more examples of such *vieilles amourettes* than those of *Ninon de l'Enclos.*

The original receipt for preparing this invaluable lotion, written in letters of gold in

the queen's own hand writing, is said to be preserved in the imperial library at Vienna. A copy, from an equally authentic source, has been inserted among a small collection of medical remedies written by one John Prevôt, and published in Germany in 1659. The account he gives of it is too curious to be omitted, and is as follows:—

"As the admirable efficacy of the undermentioned remedy has been certified to me in many instances, I shall relate by what chance I hit upon it. In the year 1606, I saw among the books of Francis Podecather, a gentleman of a most noble Cypriot family, and with whom I enjoyed the greatest intimacy, an extremely old breviary, which was held by him in the greatest veneration, as having been presented to his ancestors, as a token of mutual friendship, by St. Elizabeth, formerly Queen of Hungary. In the commencement of this book there was shewn to me a remedy for the gout, written by that queen's own hand in the following words, which I then copied:—

"I, Elizabeth, Queen of Hungary, being in the 72d year of my age, and both very in-

firm and gouty, used for one year this receipt, which was given to me by a certain ancient hermit whom I never saw neither before nor since, and was quickly cured and restored to strength, and appeared to all in a manner so extraordinary beautiful, that the King of Poland sought me in marriage, we being then both in a state of widowhood. But I refused, for the love of my Lord Jesus Christ, from whose angel I believe that I received this medicine. This is the receipt:—"

"R. Aquæ vitæ four times distilled part 3. The tops and flowers of Rosemary, part 2. To be put together in a close stopped vessel, and allowed to stand in a warm place during fifty hours, then to be distilled in an alembic, and of this once every week one drachm to be taken in the morning, either in the food or drink, and every morning the face and the diseased limb to be washed with it."

The original of this ancient receipt is written in the latin of those times, from which the above is a literal translation. Prevôt, it seems, mistook this Elizabeth for St. Elizabeth, daughter of King Andrew II., who, in fact, never was Queen of Hungary, but who died Landgravine of Thuringia, in 1235. But it has been ascertained, by the will of

the queen in question, that she actually did bequeath two breviaries, the one to her daughter-in-law, the other to one Clara Von Puckur, the similarity of whose name with that of Podecather renders it probable that she may have been an ancestress of the family in whose possession it remained.

MAGNETISM.

MAGNETIC CURES;—MESMER;—ANIMAL MAGNETISM;—SOMNAMBULISM;—DE MAIGNAUDUC;—VALENTINE GREATRAKES.

The external use of the magnet has been brought into vogue in modern times as a new discovery, but it was, in fact, known to Ætius, who lived so early as the fifth century: for that author expressly says, that those who are afflicted with the gout, or with convulsions, find relief from holding a magnet in their hand. Marcellus, who wrote in the fifteenth century, assures us that it is a sovereign remedy for the tooth-ache; Baptista Porta recommended it in the following century for the head-ache; Kircher mentions, about the same time, that it was worn about the neck as a preventive against convulsions and affections of the nerves; and,

towards the close of the seventeenth century, magnetic tooth-picks and ear-picks were fashionable specifics for pains in the teeth, eyes, and ears.

But, whatever efficacy may have been possessed by these remedies, must be attributed to the actual application of the magnet, and did not belong to that pretended science denominated *animal magnetism,* which was thus introduced :—

Towards the close of the last century, and shortly before the commencement of the French Revolution, one Mesmer, a German physician of some note, arrived at Paris, and pretended to possess a mysterious doctrine, by means of which he had performed several sudden and astonishing cures.

The properties of the loadstone, and all the electrical discoveries, led Mesmer to affirm the existence of an universal fluid, which governs the stars and the three reigns of nature. This fluid, considered in man, whom he viewed as a perfect electrical machine, he called animal magnetism. Of this he insisted that some individuals have too much, and others too little; but he supposed that

the superfluous quantity could be taken from those who have too much, and communicated to those who stand in need of it. By analogy with artificial electricity, he contended that the fingers of man may be considered as excellent points whence this fluid may be extracted, and the entire hand may serve to communicate it where it is wanting. His ordinary apparatus for proving the truth of this theory was a stand of bottles arranged in a certain order, bordered with points of iron, dipped in water at one end, and communicating at the other with the circle of sick people, who were connected to each other by a cord. This simple preparation sufficed to produce the most extraordinary effects on the imagination of persons who were rendered credulous by the hope of a sudden recovery from disease. At the commencement of the operation the patients usually appeared dejected; but as Mesmer, placed in the centre of the circle, affected, with various gestures, to extract and communicate the miraculous fluid, the sympathetic power of the imagination gradually began to take effect; the most robust men and the most de-

licate women seemed to be agitated by similar sensations, and the most extraordinary, as well as the most ridiculous scenes, were often exhibited. When the crisis of the operation approached, they fell into a kind of prophetic somnambulism, and while in this state they revealed their disorders, and, as if by inspiration, declared the most proper remedy to be applied. The imagination, which possesses the faculty of restoring as well as of injuring our organs, effected some cures, at least of a momentary nature, and many nervous persons, whose only malady existed in idea, were restored to health by the same delusion which had deprived them of it.

Two celebrated men, Duport and D'Eprémesnil, who both figured in the revolution, were the most remarkable proselytes to Mesmerism. Many others of more illustrious rank, of graver habits, and of a more mature age, were attached to his doctrine; but when the French physicians had, by invitation of government, explained the system of animal magnetism, and destroyed an hypothesis which rested on a few cures, probably the effect of the imagination rather than of

the operation of electricity, Mesmer disappeared, and the sleep-walking prophets, driven from Paris, carried their convulsions and their reveries into the country, where the good sense of the peasants opposed so ridiculous a doctrine.

To Mesmer succeeded de Maignauduc, who for a long time continued this species of quackery in London, and having filled his coffers at the expense of the public credulity, he retired to enjoy the fruits of his imposition. But several proselytes remain; and even to this day there are many persons, who not only place the most implicit confidence in the principles of animal magnetism, but who also pretend to put them in practice.

Although Mesmer was the first who attempted to rank this pretended discovery among the sciences, to determine its principles and to give it a name, yet he was not, as has been generally supposed, the original inventor of the deception. About the middle of the sixteenth century, an Irish gentleman, named Valentine Greatrakes, acquired great reputation by numerous cures of various disorders, which he effected by simply touch-

ing the part affected. Crowds flocked to him from all parts, and he performed such extraordinary cures, that he was cited in the Bishop's Court at Lismore, and not having a license as a physician, he was prohibited from practising in future. He was, notwithstanding, engaged by Viscountess Conway to visit her Ladyship, in England, for the purpose of removing an inveterate head-ache with which she was afflicted. He arrived in the year 1666, and so great was his fame, that, as he proceeded through the country, the magistrates of the different towns through which he passed requested his assistance for the sick; and his Majesty commanded his attendance at Whitehall. During his residence in London, he was attended by crowds of all ranks; and as a proof that these were not merely the simple and the uninformed, we are assured that Flamstead, the celebrated astronomer, even made a journey to Ireland, to be touched by him for a weakness of constitution. At length, however, his reputation, which was only built upon the public credulity, yielded to the force of sense and argument; and, notwithstanding many certificates

of most extraordinary cures, attested by several of the most eminent persons of the age, he retired to Ireland, and died in obscurity.

There was this great difference betwixt Mesmer and Greatrakes—the former was undoubtedly an impostor, the latter merely an enthusiast. He had been an officer in the army, and afterwards a magistrate of the county of Cork; but he retired from those situations, and giving himself up to religion, he at length became persuaded that he had the gift of curing various distempers. He ascribed many disorders to evil spirits, which he divided into separate classes, and these he drove by his touch from one part to another, to the utmost extremities of the body, from which they were then entirely eradicated. Although he was so far from convincing every one of the reality of his miraculous gift, that many wrote violently against him, yet he found some zealous advocates even among the faculty, and, on the strictest inquiry, no kind of blemish was ever thrown upon his character.

MANGANESE.

GLASS ;— ROCK CRYSTAL ;— FUSION ;— PROPERTIES OF MANGANESE ;—ANCIENT USE ;—ETRUSCAN VASES ;— DISCOVERY.

GLASS is not, as is generally believed, made in our glass-houses ; the glass-makers merely bring the glass, already produced by nature, into a state of fusion ; and afterwards form it into vessels of divers sorts. But as it is not of itself a fusible substance, it is generally mixed with some alkaline salt and calcareous earth, which necessary addition always renders it more fragile and brittle. This it is which gives the polished rock-crystal so great a superiority over the best crystal glass of our glass-houses. However, glass-makers might use a very little of the addition already mentioned, and even lessen the quantity employed, by exposing their glass

a long time to the fire; but, it must be remarked, that it then becomes so tough and difficult of fusion, that the usual method of treating it can no longer be employed. Hence those who prepare artificial precious stones, or prisms of a superior kind, must first anneal the glass in the furnace, and afterwards break it, and give the proper form to the pieces by grinding them. Sand of any kind, and every description of siliceous earth, if not too impure, suffice for common green, or blackish green glass; but the purest sand, or quartz, and the purest alkaline salts, must be used for white glass, which composition is greatly improved by the addition of some manganese to the frit, which is a mixture of sand, or siliceous earth, and alkaline salts.

In general, manganese resembles some kinds of iron-stone, and as iron was known at an early period to colour glass, it was probably by accident that manganese was discovered to render frit colourless, which it will do when added sparingly: if added in large quantities, it imparts a violet colour to the glass, something similar to that of the

amethyst. This discovery was made, in all probability, by endeavouring to colour glass with manganese, at first supposed to be a species of iron; and it was no doubt soon found that it gave beautiful shades of violet, red, and dark brown, according to the quantity of it that was used; and also that, if employed in very small quantities, it rendered the glass white.

The period when this useful discovery was made is unknown, but it was undoubtedly made use of in Pliny's time, as he speaks of a magnet used for making glass white, and manganese certainly does resembles the magnet in many respects. The word *Alabandicus*, used by the same author, has by many been thought to mean manganese, but was more probably the name for a calcareous earth, added to promote the fusion of the sand.

It is not improbable that the ancients used manganese for glazing and painting their pottery; and, indeed, it has been positively asserted, that some Etruscan vases and lamps were painted with the same manganese that we use for our earthenware.

The colours on the Etruscan vases do, certainly, bear some resemblance to those on our stone-ware, but, it must be remembered, that they might have been produced by calx of iron. The substances employed by the ancient potters can, indeed, only be determined by positive testimony or by experiments; but the former is not to be found, and the latter have not been made. It may also be observed, that in former times the same objects were often accomplished by means totally different from those now in use, and thus coloured glass was made by the Romans without any acquaintance with our cobalt or mineral purple.

The way in which manganese is supposed to have been first employed was as a magnet for attracting glass, because the ancients conceived that there existed a magnet for every other kind of metal as well as for steel; and as manganese was, in consequence of its similarity, considered as a magnet, it was subjected to experiments which led to the discovery of its real properties.

The manganese imported from Piedmont was in Germany for a long time considered

the best, which was, however, afterwards superseded by another kind brought from Perigord, in Guyenne, and called *pierre de Perigueux*, or *lapis petracorius*. This has been considered as a particular species of manganese. Its principal characters are a resemblance to burnt coal or cinder, a shining surface, and, on being fractured, an appearance of fine stripes a little coloured. A peculiar kind of metal called *magnesium*, or *regulus magnesii*, has been found in manganese; it was first mentioned in the year 1770, by a German mineralogist named Ignâtius Gottfried Kaim; but a Frenchman of the name of De la Peyrouse likewise discovered it, in a native state, in an iron mine in the county of Foix. The chief mines of manganese are situated in Germany; but it is also found in England, where the first mine was discovered by Boyle.

NITRE AND SALTPETRE.

NEUTRAL SALTS;—SALTPETRE;—LEPROSY OF HOUSES;—SODA;—NITRE;—ANCIENT USE;—ORIGIN OF THE TERM;—REGALIA.

The question whether our saltpetre was known to the ancients, is one that has occasioned as much discussion among the learned as almost any other relating to the natural history of antiquity, and still remains in a great measure undetermined.

The properties which form the essential difference between saltpetre and other neutral salts are its peculiar cooling acid taste; its fusibility when exposed to moderate heat; and its inflammability: which latter quality, when brought into action, destroys its acidity, and leaves only the vegetable alkali of which it is composed. It is chiefly employed in the fabrication of gunpowder and

of aqua-fortis, and it is also largely used as an antiseptic.

The putrid fermentation of animal and vegetable matter produces a nitrous acid, which combines with calcareous earth, and forms what is termed *earthy saltpetre;* which, being decomposed by fixed vegetable alkali, that again connects with the acid, becomes *common saltpetre.* It sometimes also happens that the nitrous acid is found united with mineral alkali, and then produces that species known as *cubical saltpetre.* These substances are produced by the spontaneous efforts of nature, aided by the combinations of chemical art; pure *native saltpetre* being rarely found except in hot countries, where, indeed, it is known to effloresce from the earth in large quantities. This efflorescence is also sometimes perceptible on walls: it is observable by the decay of the masonry, which it appears to corrode, and is the leprosy of houses alluded to in the Mosaic law.* To this incrustation the ancients gave the name of *nitron,* or *nitrum;* but it must have been

* "*Mosaic law.*" Leviticus, chap. xiv., v. 34, and following.

of very undefined quality, for it is as frequently found to consist of that mineral alkali which modern chymists term soda, as of calcareous saltpetre, and various other salts have been discovered in similar situations, produced by the same cause. The manner of procuring soda from the ashes of certain plants seems also to have been known at a very early epoch to the Egyptians; but it was not distinguished from the other salts, which it resembled, and was only known under the same denomination.

Substances so essentially different certainly ought not to have been all included under one common appellation; but when natural history was yet in its infancy, and ere it began to be considered as a science, an error was fallen into, the very reverse of that committed at present, and instead of classing every minute variety under a distinct head, according to the modern practice, objects whose properties were totally dissimilar, were comprehended under the same name: thus, at one period, the Romans designated every pulpy globular fruit as an apple; the elephant and the rhinoceros were classed

among the oxen; the sable and the ermine were denominated mice, and the ostrich took its place among the humble tribe of sparrows. It is not, therefore, to be wondered at that the ancients, who were, besides, unacquainted with any accurate method of separating salts, should have ascribed opposite and irreconcilable qualities to the nitre; or that, as they were ignorant of the use of calcareous saltpetre for the purposes of making aquafortis and gunpowder, they should have chiefly distinguished the mineral alkali, which was alone valuable to them in consequence of its uses in domestic economy, and in the various processes of fulling, of painting, and of glass-making.

Among the domestic purposes to which nitre was applied, were those of both preserving animal food from putrefaction, as well as the opposite intent of rendering meat that was too fresh, tender, by immersing it in a ley of nitre, and it was commonly added to bread, in baking, in order to render it light; practices which still prevail in the East. It was generally used both for scouring apparel and cleansing the person; which latter cir-

cumstance is distinctly mentioned in the scriptures:—

"For though thou wash thee with *nitre*, and take thee much "soap, yet thine iniquity is marked before me, saith the Lord "God."—*Jeremiah*, ch. ii. v. 22.

And we also learn from Ovid, that the Roman ladies formed from it some of their most valued cosmetics, as well as constantly employed it at the bath. It entered into the composition of many medicinal receipts, and was in the remotest ages one of the chief agents in the process of embalming.* Some agriculturists imagined that leguminous plants were improved in flavour if the pulse from which they were produced had been steeped in a solution of nitre, or if the dung with which the ground had been manured was impregnated with it; and vegetables of the cabbage tribe were strewed with it, both in order to promote their growth, and to render them tender. Others merely attributed to it the virtue of protecting the seed-corn from the attacks of insects;

* For "*the process of embalming*," see article *Museums*, vol. i. b. i.

but a general notion seems to have prevailed that it increased the bulk and quality of the grain :—

> " *Semina vidi equidem multos medicare serentes,*
> " *Et* Nitro *prius, et nigra perfundere amurca,*
> " *Grandior ut fœtus siliquis fallacibus esset.*"
>
> *Virg. Georg.* lib. i.

> " Some steep their seed, and some in cauldrons boil,
> With vigorous nitre and with lees of oil,
> O'er gentle fires the exuberant juice to drain,
> And swell the flattering husks with fruitful grain."
>
> *Dryden.*

The origin of the term *nitre* has not been defined, though it seems probable that it was derived from *Nitria*, a province of Egypt, whence it was anciently exported in large quantities. The name is of great antiquity; it occurs in the Scriptures,* and appears to have been carried from Egypt and Palestine to Greece, and thence to Italy. Some European travellers in the Levant, in the sixteenth century, having heard the name *natrum* applied to the mineral alkali produced there, conceived that it was specifically employed

* " *Scriptures.*" Proverbs, ch. xxv. v. 20. Jeremiah, ch. xi. v. 22.

to distinguish that particular species of salt from vegetable alkali, or *nitrum*; although, in fact, they are synonimous terms, the former being merely a corruption of the latter. The error, however, was adopted by Linnæus, and implicitly received by all the modern systematizers, some of whom have discoursed very learnedly upon the *nitrum* and the *natrum* of the ancients, although the latter word is not to be found in any author of antiquity. There are many reasons for supposing that saltpetre was not known in Europe until some time in the thirteenth century, when it was distinguished from the common nitre by the name of *sal nitri*, and afterwards of *sal petræ*.

When saltpetre became of importance to Government, in consequence of its employment in the manufacture of gunpowder, some of the states of Europe had recourse to a most extraordinary expedient, in order to procure it at a cheap rate. It was assumed as a part of the *regalia*, or rights attached to the prerogative of the crown, that the efflorescence on the masonry of houses, which has been already mentioned, belonged to the

monarch; and, under that pretence, persons were empowerd to search the dwelling-houses for saltpetre, and to scrape the walls whenever there was any appearance of it. The first instance of this oppression on record occurs in the year 1419, when Gunther, archbishop of Magdeburgh, farmed out this right on condition of receiving a certain quantity of refined saltpetre in return. His successors continued the practice; and it is probable that it was adopted by most sovereigns. So late as the eighteenth century, it was carried so far in some parts of Germany, that the inhabitants of towns and villages were compelled to erect and maintain walls expressly for the purpose of producing saltpetre, but under the gracious promise that the collectors should no longer be allowed to search for it in private houses. In the duchy of Wurtemberg, and in the Prussian states, where this singular tax was most rigorously enforced, it was not abolished until the year 1798, and then only upon an indemnification being given to Government for the loss.

In many parts of the East-Indies the earth is so richly impregnated with saltpetre, that

it may be extracted by lixiviation, without any other process, and, in that warm climate, brought to crystallize without the aid of fire. These advantages, combined with the low price of labour, render it so cheap, that it is now found more advantageous to import it than to manufacture it in Europe; and, indeed, the power of producing it is so limited, that all the oppressive exertions of the ancient regalia could never procure sufficient for the gunpowder used in the various continental wars. The importation was probably commenced by the Dutch, as the article appears among the lading of their ships at the earliest period of their trade with India, and they long enjoyed an exclusive monopoly of it. Whether the Portuguese brought saltpetre to Europe, on the discovery of the passage round the Cape of Good Hope, does not appear.

PRINCE RUPERT'S DROPS.

ORIGIN OF THE NAME;—FORMATION;—PROPERTIES;—BOLOGNA PHIAL.

The toys which, in this country, commonly bear the name of "Prince Rupert's Drops," are known among men of science by the name of *Lachrymæ vitræ*, and on the continent by that of *Larmes Bataviques*, or Batavian Tears. They acquired the latter appellation from their having been first made in Holland; and the first from their having been introduced into England by the celebrated Prince Rupert, in the time of King Charles II. They are formed by merely pouring a drop of fused green glass into water, by which means the rounded substance assumes an oblong form, terminating with a fine and nearly capillary extremity. If the smallest end of this frag-

ment be broken off, the whole mass instantly bursts into the finest dust, whereas the thick end will, on the contrary, withstand a very powerful blow. These singular properties did not attract the notice of experimental philosophers until the middle of the sixteenth century, when some unsuccessful attempts were made, both in Paris and London, to ascertain the principles on which they are founded; but it is probable that they must have been known in glass-houses from time immemorial, and as their formation is so simple, the discovery was no doubt made by accident.

There is another equally curious toy, formed upon a similar principle, termed the *Bologna phial.* It is a small bottle, thicker at the bottom than the top, and cooled immediately without annealing. It will bear the stroke of a mallet, or of any blunt instrument, or the concussion of a leaden bullet dropped into it from a considerable height; but if any sharp body, however small, fall into it from an elevation of only a few inches, the bottom cracks all round and falls off; and when very brittle, any hard angular substance

will pass through the bottom, however thick it may be, apparently without resistance. Hollow cups made in this manner, of green glass, some of them three inches thick at the bottom, have been instantly broken by a splinter of flint weighing only two grains, although they had resisted the shock of a musket ball from the height of three feet.

Several theories have been built upon these phenomena, but all nearly equally inconclusive, and the discovery of the cause still baffles the researches of science.

ROCHELLE SALTS.

DISCOVERY;—COMPOSITION;—PROPERTIES;—VEGETABLE AND MINERAL ALKALIES:—GLAUBER'S SALTS.

THE medicine so generally known under the title of Rochelle salts was first prepared and brought into use, in the latter end of the seventeenth century, by a French chemist of the name of Seignette. He first called it alkaline salt, then *sal polychrest,* and lastly, it acquired its present appellation from the place of his residence, which was Rochelle.

The discovery of this remedy was entirely due to accident. It is a compound of mineral alkali, soda, and the acid of winestone: Seignette, while engaged in making soluble tartar, employed the salt of soda instead of winestone, through a mistaken notion that there was but one kind of fixed alkali, and thus

unexpectedly saw a new salt produced, quite different from the soluble tartar which he intended to make, and from every other known salt. On closer examination, he found it to be a laxative; and by recommending it with confidence, and having the discretion to keep the mode of procuring it a secret, he secured an extensive sale of it during many years, and thus acquired a considerable fortune.

At length men of science investigated this secret salt, discovered its component parts, and made them generally known. The consequence of this was, a more minute inquiry into the difference between the vegetable and mineral alkalies, which has thrown much new light on chemistry, and has led to many important improvements in the arts.

In like manner the celebrated medicinal salt invented by Glauber, and known by his name, was an accidental discovery made by that chemist, while in pursuit of the philosopher's stone.

SEALING-WAX.

SEALING-EARTH;—BEES'-WAX;—BLUE-WAX;—ANCIENT MODE OF SEALING LETTERS;—INVENTION OF SEALING-WAX;—ANTIQUE SEALS;—WAFERS.

THOSE writers who treat of ancient diplomas, mention five materials, besides metals, wherewith letters and deeds were sealed; namely, cement, paste, bees'-wax, sealing-wax, and sealing-earth. The latter was in use among the Egyptians at the earliest epoch of their history: when their priests selected cattle for sacrifice, they bound upon their horns a piece of paper, on which they placed some adhesive earth impressed with their seal, to mark the destined victims. This was probably the first substance employed for sealing. Frequent mention of it occurs at a later date in both the Greek and Latin au-

thors; but the particular kind of earth of which it consisted has not been ascertained, and none that we are acquainted with would answer a similar purpose; it therefore seems probable that it was not used in its natural state, but was, perhaps, some coarse species of cement.

Bees'-wax, in its natural state, is supposed to have been used in Europe time immemorial for the purpose of sealing: but it is not easy to determine whether yellow or bleached wax was employed for that purpose; for age occasions the former to lose much of its colour, while the latter acquires, with time, a yellow tinge, so that the oldest seals that have been preserved, appear to have been of white, and the more modern of yellow wax, although it is probable that the contrary was the fact. In process of time this wax was coloured red, and, at a still later period, green and black. It has been remarked, as a matter of some surprise, that seals of blue wax have never been discovered: but this ought not to excite astonishment, as the art of communicating a blue colour to wax has not yet been invented, nor does it seem pro-

bable that it ever will, for the blue vegetable dyes all lose their natural tint, and acquire a greenish hue, on being combined with wax.

It is evident, however, that wax, in its natural state, could only serve to receive the device of the signet, and could not effectually close a letter; for the latter purpose, therefore, a silken thread was usually wound round the cover, and, for the greater security, was drawn through a piece of wax on which the seal was impressed.

The invention of sealing-wax, which served the double purpose of security and ornament, is not supposed to have been known in Europe before the beginning of the sixteenth century. The oldest authenticated seal of this kind, that is known to be in existence, is on a letter, dated London, the 3d of August 1554, to the Rheingrave Phillip Francis Von Dhaun, from his agent in England, Gerhart Hermann: it is of a shining dark-red wax, and bears the initials of G. H. Mention is indeed made, in the "Original Letters written during the reign of Henry VI., by John Fen," of a letter, in the year 1455, the seal of which, he says, "is of red wax;" but by this, no

doubt, nothing more than common wax is to be understood. We are also ignorant of the country to which this invention belongs. It may be attributed with much appearance of probability to Spain, from its having been originally termed *Spanish-wax;* but this circumstance loses much of the importance that would otherwise attach to it, from the well-known fact, that it was customary in those days to call every thing that was new or curious "Spanish." It has been ascribed to a Frenchman of the name of Rousseau, at so late a period as the year 1640; but this is evidently a mistake. That person, it appears, had long travelled in various parts of the East Indies; and having, on his return to Paris, where he resided as a merchant, lost all his property by an accidental fire, it occurred to him, in his endeavours to support a large family, to make sealing-wax from gum-lac, "*as he had seen it prepared in India.*" This was patronized by Louis XIII. and his court, and Rousseau gained by it, in the first year of his enterprize, full 50,000 livres. From this, however, it would appear that the sealing-wax now in most general use was

an improvement actually introduced by him; for it certainly is chiefly composed of gum-lac, whereas that formerly employed, and still occasionally, although the quality is indifferent, was a composition of either melted resin, or purified turpentine and cinnabar.

With regard to the antiquity of wafers, but little has been collected. Paste of flour was, indeed, very anciently used for closing letters; but that substance is not supposed to have been employed for seals more than about two centuries, and the oldest that has yet been discovered on the Continent is a red wafer seal affixed to a letter, dated from Spire, in the year 1624.

SLOW-POISON.

ANCIENT POISONS;—OBEAH MAGIC;—HILRONYMA SPARA; TOFANIA;—AQUA TOFANA;—MANNA OF ST. NICHOLAS; —HISTORY OF THE MARCHIONESS DE BRINVILLIERS AND THE CHEVALIER DE STE. CROIX;—THE CHAMBRE ARDENTE;—SUCCESSION POWDER;—POWST;—COMPOSITION OF THE AQUA TOFANA;—CATASTROPHE OF THE MARQUIS DE BRINVILLIERS;—EFFECTS OF POISONS.

By slow-poison we generally understand all those preparations which can be administered imperceptibly, and which gradually weaken the vital powers, and finally cut short the life of man. That the ancients were acquainted with poisons of this kind, can be proved by the testimony of many of their authors; some of whom mention preparations that could be moderated in such a manner as to produce death at any period, from two or three months to as many years.

But these were composed from vegetable and animal substances, among which the most remarkable are supposed to have been aconite and the sea-hare, or *Lernæa* (the *aplysea depilans* of the Linnæan system), and the more active and powerful mineral extracts seem to have been unknown to them.

It cannot be objected that such discoveries were beyond the chemical knowledge of the period to which they are ascribed; for the unlettered natives of Africa, and the Indians of America, are in possession of poisons of this kind, and apply them with such skill, that those to whom they are administered, if not destroyed within a given time, die at least in a lingering manner, and without being sensible of the treachery of which they are the victims. It is this secret which forms the foundation of that mysterious influence, still possessed by some old negroes in the West-Indies over their fellow slaves, so well known under the name of the *Obeah magic;* the dread of which is so great, that the unfortunate beings who are only threatened with its operation, pine away in mere terror of the consequences, and its real effects are

so certain, that no precaution can avail to save from destruction those who are its intended objects. As an instance of which, it is not many years since an African negro was executed in the island of Martinique, for practices of this kind, who, in his last moments, confessed that he had secretly administed poison to more than twenty of his master's slaves, all of whom perished without the least suspicion of the cause.

But poisons of this nature have never been prepared with greater art, nor any where more extensively used, than in Italy and France during the seventeenth century. It was remarked at Rome, about the year 1659, that many young married ladies suddenly became widows, and many husbands who were known to have become disagreeable to their wives unexpectedly died. Suspicion fell on a society of females under the direction of an old woman, who pretended to foretell future events, and who had in fact correctly predicted the death of many persons, to those who were interested in the event. A spy was employed, who introduced herself to this sorceress as a person of distinction, suffering

under the tyranny of an imperious husband, of whom she wished to be rid; and by means of this stratagem her secret was detected. The whole society were then arrested, and put to the torture; and the hag herself, whose name was Hieronyma Spara, along with several others, publicly executed. It appeared that many of the Roman nobility were implicated in this affair; and, notwithstanding the severity with which it was visited, traces of the same suspicious practices were remarked for a long time afterwards. Spara was a Sicilian, and was said to have acquired her knowledge from the celebrated Tofania; but the difference of their age renders it more probable that she was the instructress of the latter.

Tofania, if not the inventress of the far-famed drops which from her obtained the name of *aqua tofana*, at least carried the diabolical art of preparing them to the greatest perfection. She first resided at Palermo, but afterwards at Naples, where she was more particularly known, and whence the drops have also been commonly called *acquetti di Napoli*. There was, at Bari, in

the kingdom of Naples, a miraculous oil, said to distil from the tomb of St. Nicholas; and the credulity of the people inducing them to employ it as a remedy for certain disorders, it was sold in small glass phials bearing the image of the saint, and an inscription purporting that they contained "*manna of St. Nicholas of Bari.*" The apparent sanctity of these securing them from suspicion, Tofania employed them for the distribution of her drops: but it seems that, like her friend Spara, she reserved them for the service of those of her own sex to whom the yoke of matrimony had become irksome; and, if the history of those times be not incorrect, the toilet of few married ladies of distinction at Naples, and other parts of Italy, was without a phial of the precious manna. This poison was limpid and tasteless as pure water, so that it was impossible to guard against its attacks: a few drops, administered at different periods, were sufficient to destroy a man by slow and imperceptible degrees; and it was supposed, that through its effects not fewer than six hundred persons perished.

Tofania lived to a great age; but suspicion having at length fallen on her, she took refuge in a monastery, from which she was dragged by the officers of justice, notwithstanding an outcry raised by the clergy at the violation of ecclesiastical privilege. Being put to the rack, she confessed her crimes, and acknowledged that, the day before she absconded, she had forwarded two boxes of *manna* to Rome, where it was actually found in the custom-house; but it never appeared who had ordered it. She was afterwards, it is said, privately strangled: but in the accounts of her fate there is considerable discrepancy; for Labat says that she was arrested in 1709; Keysler, another traveller, affirms, on the contrary, that she was still living at Naples in 1730, and resided in a convent, in which she was protected as in a sacred sanctuary, and where many strangers used to visit her from motives of curiosity; and Garelli, who was physician to Charles VI. king of the two Sicilies, and whose authority on this point is most to be relied on, writes to a friend, about 1719, that she was still in prison at Naples.

This infamous art, however, no where ever excited greater interest than at Paris. About the year 1670, Margaret d'Aubray, wife of the Marquis de Brinvilliers, a nobleman of large fortune, commenced an intrigue with a young officer of a distinguished but needy family, named Godin de Ste. Croix. After a short period she lost her husband, whose property she had partly dissipated; and still openly continuing her intimacy with De Ste. Croix, her father procured a *lettre de cachet*, had him arrested, and thrown into the Bastille. He there got acquainted with an Italian, who instructed him in the manner of preparing poisons. After a year's imprisonment he was released, and immediately flew to the Marchioness, to whom he communicated the baneful art, which she undertook to practise for the improvement of their circumstances. She then assumed the garb of a nun of the order of *Les Sœurs de la Charité*, distributed food to the poor, administered to the sick in the *Hôtel-Dieu*, and thus tried the effect of her poisons, undetected, on these helpless wretches. She bribed a servant to poison her own father,

and her brother, and endeavoured to poison her sister: the two former perished; but a suspicion having arisen of the cause of their death, the sister was on her guard, and thus escaped. She then, however, avoided detection, and the guilty pair continued their villainous practices, in security, until they were at length providentially brought to light in the following manner:—

De Ste. Croix, while preparing poison, always wore a glass mask; but this once happening to drop off by accident, he was, as it is said, suffocated by the vapour, and was found dead on the floor of his laboratory. As he was without apparent heirs, Government caused an inventory to be taken of his effects, among which there was found a sealed casket, with a label to the following effect:—" I hereby intreat, that those into whose hands this box may fall, will have the kindness to deliver it into the hands of the Marchioness de Brinvilliers, who resides in the *Rue neuve St. Paul*, as its contents concern her alone, are her sole property, and can be of no use to any other person; and in case that she should die before me, I beg that

it may be burned, with all that it contains, without opening it. That no one may plead ignorance, I swear by that God whom I adore, and by all that is sacred, that I advance nothing but the truth; and if these, my just and reasonable wishes, be not complied with, I charge the conscience of those who infringe them with the consequences, both in this world and the next, in order that I may relieve my own: protesting at the same time that this is my last will. Done at Paris, this 25th of May, in the afternoon, 1672.—De Sainte Croix." The singularity of this request formed the strongest inducement not to comply with it: accordingly the casket was opened, and in it were found various pacquets, with inscriptions signifying that they contained poisons, the effects of which had been proved by experiments on animals.

The Marchioness, having failed in an attempt to obtain possession of the casket, fled to England, and thence to Liege, where she took sanctuary in a convent. In order to entice her from this privileged abode, consecrated by folly for the protection of vice, a

police officer, in the disguise of an Abbé, obtained an introduction to her, and assuming the character of a lover, persuaded her to leave the convent on a party of pleasure, and then arrested her. At first she denied all that was laid to her charge; and while in prison, she behaved with great levity, passing the greater part of her time in playing at picquet. But she had been guilty of the extraordinary imprudence of making out a catalogue of her crimes, which, in her own hand-writing, was found among her effects in the convent. Upon this she was convicted; and having afterwards acknowledged the horrid detail, which contained a series of the most shocking atrocities, she was publicly beheaded, and afterwards burned at Paris, on the 16th of July 1676, and met her fate with a degree of resolution amounting almost to unconcern. It may afford matter for curious speculation to the disciples of Lavater to learn, that nature had not been sparing to the Marchioness of the beauties of her sex: her features were regular, the contour of her face extremely graceful, and her whole air wore that appearance of serenity,

which is considered as an indication of virtue.

But the punishment of this French Medea did not put an end to the practice of secret poisoning; which, on the contrary, was carried so far, that, in 1679, a special court, called the *Chambre ardente*, was instituted to try offenders of this class. Among the persons brought before this tribunal were two women—La Vigoureux, and La Voisin. The latter was a midwife: but both were also pretended fortune-tellers, and privately sold philters and slow-poison; which last, from the use that was supposed to have been made of it by impatient heirs, obtained the quaint title of *succession-powder*. Curiosity had induced many persons of the first rank to visit these women in their apparent character of fortune-tellers, without any intention of employing them for a worse purpose; and of all those who had thus been the dupes of their imposture a list was found in the possession of La Voisin. Among these was the distinguished name of the Maréchal de Luxembourg, who was in consequence arrested, and detained for some months in the Bastille.

Several persons of condition were for a long time imprisoned, although afterwards acquitted; some of inferior rank suffered by the hands of the common hangman; and, on the 22d of February 1680, La Vigoureux and La Voison, after having had their hands first bored through with a hot iron, and then cut off, were burned alive.

Various conjectures have been formed respecting the composition of these poisons. For a long time the sale of aqua-fortis was prohibited at Rome, from an idea that it formed the chief ingredient; and at Paris it was once imagined, that the succession-powder consisted of diamond-dust, and afterwards, that it was composed of sugar of lead: but all these surmises have been proved to be equally unfounded. The casket of De Ste. Croix contained regulus of antimony, sublimate, vitriol, and opium, in an uncompounded state, together with a large quantity of prepared poison, the component parts of which the chemists were not able to discover. The *aqua tofana* is said to have been an extract of opium and cantharides; and this supposition has gained the greater credit from

its being generally understood that the poison known in the East-Indies by the name of *powst* is obtained from the juice of the poppy. But on this point, the evidence of Garelli, whom we have already mentioned, seems to be conclusive; and he says, that he was informed by his Majesty Charles VI., to whom all the judicial procedure, together with the confession of Tofania herself, had been transmitted, that it was nothing more than a decoction of crystallized arsenic, with the addition (probably for the mere purpose of disguising it) of the herb cymballaria.

Whatever may have been the ingredients of these poisons, their effects appear to have been uniformly the same, and are thus described in the account of the symptoms that attended the death of the father of the Marchioness de Brinvilliers:—"After having languished during a considerable period, he was seized with a loathing of food, and his stomach rejecting every kind of aliment, he was reduced to extremity, and at length expired without any fever, but with a strong sense of heat in the stomach. During the last three days he perceptibly wasted, and

towards his dissolution he had become much shrunk. On opening the body, the stomach and the duodenum were discovered to be black, and sloughing off: the liver was mortified, and wore the appearance of being burned." The son of Monsieur d'Aubray lingered in a similar manner during three months, and his intestines were found in the same state: and on the decease of Charles XI. of Sweden, who is known to have died of the effects of slow-poison, which occasioned a consumptive disease, his stomach and liver were observed to be ulcerated.

It, however, is not probable that poison can act in a precisely similar manner upon every constitution; nor can it, for the same reason, be true, that it can be so prepared as to occasion death within a given period. The circumstances attending its administration can seldom be ascertained, and when death is attended with any mysterious appearance, it is too much the custom to attribute it to this cause. Thus, in France, the extraordinary deaths in the family of Louis XIV., and, at a more recent period, that of Madame de Pompadour, and those of the Dauphin and Dau-

phiness, the parents of his present Majesty, have all been ascribed to slow poison; and although that opinion has been combated with great force and ingenuity, by that very able writer Monsieur Lacretelle, in his late "History of France during the eighteenth Century," it nevertheless continues to be that of a great majority of the nation.

STEEL.

PROPERTIES;—FORMATION;—ANCIENT NAMES;—ANCIENT AND MODERN PROCESSES OF MAKING STEEL;—HARDENING WATER;—WOOTZ.

Steel is the same metal as iron, but possesses some remarkable properties which distinguish it from common iron. It has a much greater degree of hardness than common iron, which it is capable of filing; strikes fire with vitreous stones, and scratches the hardest glass; is heavier, and emits a stronger sound than iron; exhibits a finer grain when fractured; is capable of bearing a very bright polish, and is susceptible of greater elasticity. It likewise becomes more slowly magnetic, but retains that power longer; is not so subject to rust, and gives fewer sparks than iron, when ignited. It assumes various tints in the fire, and when

heated, is soon cooled by being immersed in cold water, which renders it harder, more brittle, and by far less pliable than iron. It is not known whether iron is changed into steel by being condensed, or by the loss or addition of carbon, caloric, manganese, molybdæna, or some other component part. However, it is certain that the invention of steel is of very great antiquity, as, although we do not find any distinct mention of it in the Old Testament, still it is clear that it was known to the Greeks in the time of Homer, and received from them several names, the most common of which was *stomoma*—though this word is thought to imply the operation of steeling, or the steeled part of an instrument, rather than steel itself. *Chalybs* was a name given to steel from the Chalybes, a people inhabiting the southern shore of the Pontus Euxinus, between Colchis and Paphlagonia, which country was renowned for its mines, and particularly for its iron and steel works; some derive the name of this people from the chief article of their commerce, which derivation is the more probable, as a river of Spain, where there were

steel works, was, according to Justin, called *Chalybs*, but at a much later period.

Adamas was another word which first signified steel, and many epithets derived from *adamas* are applied to articles made of steel and iron. This name was not given to the diamond until a late period.

The Romans borrowed the word *Chalybs* from the Greeks, and it is thought by many that they likewise gave the name of *acies* to steel; but *acies*, in reality, means only the cutting part or edge of any instrument, and not the steel itself. From this word the Italians have, notwithstanding, derived their *acciajo*, and the French their *acier*.

Two methods of making steel are at present employed: the first of which is by fusion, either from iron-stone or raw iron; the second by cementation, the antiquity of which process is unknown; but the former, as practised by the Chalybes, has been twice described by Aristotle. However, the steel of the ancients, by not being cemented, was capable of being hammered, and was not near so brittle as the hardest we are acquainted with.

The method used in Spain by the Celtiberians for preparing steel, was, first to bury the iron in the earth, and to leave it in that situation until the greater part of it became covered with rust; what remained, without being oxigenated, was made into weapons, particularly swords, with which bones, shields and helmets might be cut asunder. However improbable this may appear, it is yet certain that the same method is still practised in Japan; and Thunberg informs us, in his travels through that island, that the sabres made there are so incomparably tempered, that a nail can with ease be cut through by them without injuring the edge. It has, indeed, been supposed that the softer parts of iron are first converted into rust, and that what remains is properly the substance which we call steel. In support of which theory it has been remarked, that on digging up the floor of an old house in Göttingen, an anvil was found which had lain for many years buried in the earth: it still retained its original form, but was become so soft that it could be easily crumbled to pieces; and,

when broken, the fracture every where displayed small white grains of a metallic brightness, closely resembling polished steel.

The art of hardening steel by immersing it in cold water of a sudden, when red hot, is of great antiquity. Homer alludes to it in his Odyssey, when relating how Ulysses put out the eye of the giant Polyphemus with a burning stake :—

> "Ως δ' οτ' ανηρ χαλκευς πελεκυν μεγαν, ηε σκεπαρνον,
> Εν υδατι ψυχρω βαπτει μεγαλα ιαχοντα,
> Φαρμασσων (το γαρ αυτε σιδηρου τε κρατος εστιν)."
>
> *Lib. ix. l.* 391.

Sophocles likewise has used the comparison of being hardened like immersed iron ; and Salmasius has quoted the work of an old Greek chemist, who treats on the method of hardening iron in India. Several rivers and wells were in great repute among the Romans for hardening iron, and, for that reason, had steel works erected near them, although at a great distance from the mines. Some articles of iron, which were not required to be very hard, were immersed in oil.

It is said that the Archduke Cosmo, in 1555, prepared a liquid from certain herbs, which rendered tools, immersed in it, when red-hot, so hard as to be able to cut a large block of porphyry, and to form it into a basin for a well; but the herbs of which this composition was made are unknown. That any herbs should possess such power is indeed very questionable, for we learn from the latest researches, that all kinds of known hardening fluids hitherto invented are in nothing superior to common water. Some writers have affirmed, that a water might be made capable of rendering porphyry soft, but this is probably an error.

The invention of converting bar iron into steel, by immersing it into other fused iron, and leaving it in that state several hours, is generally ascribed to Reaumer: but this process had been mentioned by authors who lived prior to his time, as one well known and practised in their days.

Among the dearest kinds of steel mentioned by ancient writers were the *ferrum Indicum* and *Sericum*. A hundred talents of

the former, which appears to be the *ferrum candidum*, were sent as a present to Alexander in India. The method of preparing it is yet a secret, although it is probable that it is still prepared in that country, and known under the name of *wootz:* it is supposed to be a kind of fused steel.

SYMPATHETIC INK.

ANTIQUITY OF THE INVENTION;—MILK;—METALLIC SOLUTIONS;—MAGNETIC WATER;—COMMON SYMPATHETIC INK;—ORIGIN OF THE NAME.

If we apply the name of sympathetic ink to every fluid which, when written with, the letters do not leave any visible impression on the paper, but yet become legible after a certain operation for that purpose, such liquids were certainly known at a very remote period. They are mentioned by many ancient authors; and among the methods by which Ovid counsels young ladies to elude the vigilance of guardians, in an epistolary correspondence with their lovers, he particularizes that of writing with new milk, and of rendering the letters conspicuous by means of soot or charcoal-dust:—

"*Tuta quoque est, fallit que oculos, e lacte recenti*
Litera: carbonis pulvere tange; leges."
De Arte Amand, lib. iii.

New Milk, or pointed spires of flax, when green,
Will ink supply, and letters mark unseen.
Fair will the paper shew, nor can be read,
'Till all the writing's with warm ashes spread.—*Congreve.*

In modern times the ingenuity of the sex is not taxed for expedients of this kind: the art of chemistry has been enlisted into the service of Cupid, and sympathetic ink is every where to be found, which conceals the contents of a billet-doux from the eyes of all but the favoured possessor of the secret.

For this purpose certain metallic solutions are employed, which being in themselves nearly colourless, are nevertheless susceptible of being made visible, either by being washed over with some other solution, or fumigated with its vapour.

Among these, none has excited more astonishment than a composition which becomes instantly black on being exposed, even at a considerable distance, to the vapour of arsenical liver of sulphur. Such, indeed, is the penetrating quality of the vapour, that

the change in colour will be effected, even should the writing be placed on the opposite side of a thin partition; and it is, therefore, often employed with success by jugglers. It is a French invention; but the discovery has been attributed to accident, and probably is not very ancient, as the first mention of it occurs in the works of Borel, printed in 1653, in which it is ascribed to an apothecary of Montpelier, named Brosson. It is there called *magnetic water;* and its composition and effects are thus described :—"let quick-lime be quenched in pure water, and while cooling, add to it some orpiment which had been heated upon warm ashes, strain the liquor, and preserve it in a bottle closely stopped; then boil pounded litharge of gold in vinegar, and in a brass vessel, during half an hour; filter it through paper, and preserve it in a similar manner. If you write with this last solution, the writing will be invisible when dry, but on being washed with the first, will immediately become black; and, what is truly surprising, although sheets of paper, or even a board, be placed between the writing and the liquid, the effect will still

be the same, and the intervening substance will have been penetrated without any apparent trace." From this account it would appear that the inventor himself was ignorant of the effect to be produced by fumigation.

Another curious kind of sympathetic ink, and that in most general use, is prepared from cobalt. Writing executed with this becomes invisible in the cold, but re-appears, of a beautiful green colour, on being exposed to the fire; and the same phenomenon occurs so often as the experiment is repeated. This invention was, for a long time, ascribed to a Frenchman of the name of Hellot, who was, indeed, the first to make it publicly known; but it was really discovered in the beginning of the last century, by a German lady, whose name has not been ascertained.

After the visionary notion of the occult sciences was exploded, it became customary to attribute to magnetic effluvia, phenomena of which the principles were unknown, and more especially those which appeared to act without any visible or sensible agency; and hence the origin of the title "*magnetic water*" formerly applied to this fluid. Others

concealed their ignorance under the equally specious cloak of a vague principle which they termed *sympathy*, as, in later times those of attraction and electricity have also been often employed; and from thence was derived the term which it still bears, in defiance of sense and science.

TIN.

ANTIQUITY OF TIN;—STANNUM;—ELECTRUM;—CASSITEROS;—TIN TRADE OF THE PHŒNICIANS;—CASSITERIDES ISLANDS;—ICTIS;—DISCOVERY OF TIN IN GERMANY;—ART OF TINNING.

It is commonly supposed that the metal which we call tin, was known as early as the time of Moses, as it is imagined that mention is made of it, under the name of *bedil*, in several parts of the Holy Scriptures.* That the Greeks and Romans, although not possessing mines of this metal, were acquainted with it, is most certain, as vessels of tin have been sometimes, though very rarely, discovered among the Greek and Roman antiquities.

* "*Holy Scriptures.*" Numbers, ch. xxxi. v. 22. Ezekiel, ch. xxii. v. 18, 20; ch. xxvii. v. 12. Zacharias, ch. iv. v. 10.

It has been generally supposed that the metal termed *stannum* by the ancients was the same as our tin; but this substance was, according to Pliny, obtained from a metal called *plumbum nigrum*, commonly mixed with silver, and, without doubt, the same as our lead. That part of it which melted first, was called *stannum*, and was, in all probability, a metal nearly resembling our tin; indeed the French *étain*, the English and low German *tin*, and the high German *zinn*, were apparently derived from the Latin *stannum;* that portion which was next melted was termed *argentum*, or silver, and what remained in the furnace was denominated *galena*, which, being once more fused, gave *nigrum plumbum* unmixed with the other component parts. *Stannum* was, therefore, probably a metal composed of lead and silver, for, it must be remarked that all kinds of lead ore, except that found at Bleyberg near Dillac, in the Duchy of Carinthia, contain a portion of silver, and some in such quantities, that they might with great propriety be called silver ores, or rather argentiferous lead ores, or plumbiferous silver

ores. We find mention frequently made by the ancients of lead unmixed with silver, but it should be recollected that they paid little attention to a small admixture of silver, and never separated it but when it might be obtained in sufficient quantities to defray the expenses of smelting, which would certainly never be the case were only a few ounces, or even a pound of silver, contained in a quintal of lead.

A great deal of lead was obtained by the ancients from argentiferous ores, when these metals were separated. The ore was first pounded very fine, then washed and roasted, and afterwards formed into a powder or paste, which was then put into a furnace, and gave by the first fusion a regulus composed of silver and lead, and called *stannum ;* to separate the silver, it was again fused in a particular refining furnace with a hearth of lixiviated ashes. Silver was thus obtained, and that substance called by Pliny *galena*, or *molybdæna*, which, by a third fusion, produced lead. These three parts, namely, *stannum*, *argentum*, and *galena*, or *plumbum nigrum*, were considered by the above-mentioned

author as the component parts of lead ore, but not indeed according to the present signification. This shews that the *stannum* of the ancients was not our tin, but the substance denominated *werk* in our smelting-houses. *Electrum* was a metal partly composed of silver and partly of gold, the art of separating which was unknown to the ancients.

Amongst some of the oldest church vessels are some which have been considered *vasa stannea*, and which, when scoured and polished, have a silvery brightness, and become of a greyish colour if left long without cleaning.

It is not probable that the Phœnicians could have obtained tin from Spain, Portugal, and England, in such quantities as to have distributed it all over the old world so early as we find mention made of the word κασσιτερος by the Greeks, which, in all likelihood, meant nothing more than the *stannum* of the Romans. That real tin was afterwards known to the Greeks is most certain, but the express time when they first became acquainted with it has not been determined; and, probably, they considered it as a variety of their

κασσιτερος or *stannum*, as the Romans declared both to be a variety of lead, and the Greeks gave no new name to the real tin. However, it was probably named at one time Tyrian, or Celtic tin, on account of Tyre being the principal mart for this metal, for we find mention made in Aristotle of τον κασσιτερον τον Κελτικον, which was no doubt the distinction drawn between their own and foreign tin.

The words *incoquere* and *incoctitia*, used by the Latins, seem to imply that they were acquainted with the art of tinning, by immersing vessels, as at present, into melted tin, although they have left us no account of it, and Pliny merely says, that a coating of *stannum* improved the taste of food, and guarded against verdigris. Among those vessels found at Herculaneum, the greater part were of copper or *stannum*; some silvered, but none tinned.

Several pieces of tin were dug up in Yorkshire in the beginning of the last century, and some tin vessels, with Roman inscriptions on them, were found in 1756, in Cornwall, which are the only two instances

of cast-tin having been known to be manufactured by the ancients.

The history of the tin trade of the Phœnicians, Greeks, Gauls, and Romans, is very doubtful, as is also the situation of the Cassiterides Islands, from which they procured their tin, and which have been generally supposed to be the Scilly Islands, with part of the coast of Cornwall, which, at a distance, wears the appearance of an island.

No proofs of the Phœnicians having worked mines there can be brought forward, but, from various antiquities, it is supposed that the Romans dug up the ore themselves from the mines, and were in possession of works for extracting the metal.

Ictis, an island to which the Britons carried tin, and whence it was exported by the Gallic merchants, has been considered to be the Isle of Wight; but some think it to have been a general appellation for a peninsula or bay, as *ik* or *yk* is a common termination of the names of the creeks in Cornwall.

Most English writers assert that tin was first discovered in Germany in 1241, by a Cornish man, who had fled there on account

of a murder which he had committed; but German writers do not mention this circumstance; on the contrary, they say that tin was discovered there in 1146 by a peasant of the village of Chodicze, named Wnadec.

The art of tinning plate-iron was invented either in Bohemia or Germany, but at what period is uncertain.

In 1670, an Englishman of the name of Andrew Yarranton, was sent to Saxony to learn the process of tinning, where, having acquired the necessary knowledge, he returned to his native country, bringing with him some German workmen, and established a manufactory of tin-plate. But a person of distinction having made himself acquainted with the art, obtained a patent for the process; in consequence of which the undertaking in which Yarranton had engaged was abandoned, and yet no use was subsequently made of the patent, and the manufacture was not recommenced until about the year 1720, when it is supposed to have been undertaken at Pontypool in Monmouthshire.

VERDIGRIS.

ÆRUGO;—ANCIENT PROCESS OF MAKING VERDIGRIS;—USE;—MODERN MANUFACTURE.

Various contradictory opinions have been entertained respecting the preparation of verdigris; the present process is nearly similar to that employed by the ancients. Every natural green copper calx was by them denominated *ærugo*; but it is certain that their artificial *ærugo* was simply our verdigris, or copper converted into a green calx by vinous acid. The method of procuring this substance was easily seen, as copper, when exposed to acids, invariably contracts a green rust. The ancients employed for this purpose either plates and vessels, or filings and shavings of copper, with the sourest vinegar,

or the lees of wine, or the stalks and skins of grapes, after the juice has been pressed from them. Sometimes plates of copper were exposed to the vapour arising from vinegar confined in close vessels, sometimes the vinegar was poured on them, and not unfrequently copper filings were pounded with vinegar in a copper mortar, till they became green calx.

Verdigris was, at first, principally used medicinally, when the copper calx was compounded with various salts and other ingredients. One of these compositions was called vermicular verdigris, probably on account of its assuming the appearance of worms or threads. Verdigris was also used as a colour, for which reason it has been reckoned among the Pigments by Vitruvius.

The greater part of our verdigris was formerly manufactured at Montpelier. The process is simple: the dried stalks of grapes being steeped in strong wine, are brought to a sour fermentation, after which they are placed in an earthen-pot, with alternate layers of plates of copper, the surface of which becomes corroded in a short time, and the calx is then scraped off.

Swedish copper is chiefly employed in this manufacture, which was carried on very profitably at Montpellier so early as the fifteenth century. It still flourishes to a considerable extent, both there and in other parts of the south of France; but experiments have been made in other countries, by which it has been discovered that copper may be corroded by means of mineral acid; which process is much less expensive.

ULTRAMARINE.

DESCRIPTION AND PROPERTIES; — LAPIS LAZULI; — SAPPHIRE; — CÆRULEUM; — EXPERIMENT OF SIR HUMPHRY DAVY; — DERIVATION OF THE WORD LAZULI; — LAZURIUM.

Ultramarine is a very fine blue powder, nearly resembling, in colour, the corn-flower, or blue-bottle, and has the peculiar property of neither fading nor becoming tarnished, when exposed to the air or to a moderate heat. On this account it is used in painting, but not to so great an extent as before the discovery of smalt, which is a much cheaper article. It is composed of the blue parts of the lapis lazuli, which is found in the mountains of that part of Tartary called Bucharia, whence it is sent to the East-Indies, and from thence to Europe. Lapis lazuli being ex-

tremely scarce, and consequently dear, other stones of a similar nature are often substituted for it, and hence many contradictions are to be found in the works of authors who speak of its properties and country. Whether the Greeks and Romans were acquainted with ultramarine is uncertain, for although, in the decline of the Roman language, we find the word *ultramarinum*, yet it certainly never meant a paint. However, it is probable that the lapis lazuli was known to them, and was the sapphire of the ancients, as it was of a sky-blue colour, with a violet or purple shade, and sometimes was of a dark or blackish blue colour. It was likewise spotted with a great many gold or golden-yellow points, and was capable of being polished or cut; but, if not perfectly pure, and unmixed with any hard extraneous particles, was unfit for the lapidary.

It was often procured in such large pieces as to be employed for inlaid or mosaic-work, and was not unfrequently compared to copper-blue, copper-ore, and earth and stones impregnated with that metal. Its medicinal effects were such as are ascribed to copper

calx, and it formed veins in rocks of other stones. There is no doubt that a stone with these properties could not be the sapphire of our jewellers, but was most certainly our lapis lazuli, which accords with the above description in every respect. The blue colour of the lapis lazuli has, however, been proved to originate from iron, and not from copper, as was generally supposed. The medicinal properties of the sapphire of the ancients could only be produced from a mixture of copper, which exists in a spurious species found in Persia, so that it is clear that they considered this "Armenian stone," or false lapis lazuli, to be the real kind.

It cannot, therefore, be doubted that the ancients were acquainted with our lapis lazuli; but whether they used it as a paint, or prepared ultramarine from it, has not yet been ascertained. However, although it is possible that their *cæruleum* may sometimes have been real ultramarine, yet it is probable that, in general, it was merely copper-ochre. This inference has, indeed, been lately established, since the period when Professor Beckman wrote, by the experi-

ments of Sir Humphry Davy. In clearing away the rubbish within the baths of Titus, the walls of which display many beautiful specimens of fresco painting, the painter's room was discovered; and in several of the jars were found different kinds of paint, among which was a quantity of the beautiful celestial blue in question. Sir Humphry not only succeeded in analyzing this substance, which he found to consist of a frit of copper, soda, and silex, but recomposed it from fresh materials, so as to produce the identical colouring matter.

The term lazuli is undoubtedly of Persian origin, from which country the stone has hitherto been brought. The original word is *lazuardi*, which, in common pronunciation, sounds like *lazurd*, and this the Arabians have corrupted into *lazur*, conformably to their custom of confounding the letters *r* and *l*. It properly signifies a blue colour, as well as the mineral, but was at first used in Europe to express blue stones, and blue colours employed in painting, and also mountain blue impregnated with copper. The word *lazurium* may be found in writings so

far back as the sixth century; and we find in the receipts for painting given in the eighth century, one for preparing a kind of blue denominated *lazuri*. It may be seen, from a passage of Arethas in the eleventh century, explaining a verse of the book of Revelations,* that sapphire was that stone from which *lazurium* was made, which is a strong proof that the sapphire of the ancients was our lapis lazuli, and appears to be the first certain mention of the real ultramarine.

The word *ultramarine* or *azurrum ultramarinum* seems to have been common about the end of the fifteenth century. In the beginning of the sixteenth century, Vanuccio Biringoccio, gave directions for preparing the real ultramarine, which he has sufficiently distinguished from copper azure, or *azurro dell' Alemagna*, describing it as being made from the lapis lazuli, which is the matrix of gold-ore. The stone, after being pounded and washed, was reduced to an impalpable powder, and afterwards brought back to its

* Revelations, ch. xxi. v. 19.

lively and beautiful colour by means of a certain paste made with gum, when it was refined and dried. This composition was capable of withstanding both fire and water. In the beginning of the sixteenth century the father of the celebrated Giambatista Pigna, an apothecary at Modena, acquired immense riches by a preparation of ultramarine. Alexius Pedemontanus* has been thought to have first mentioned ultramarine, but this cannot be true, as he wrote in the beginning of the sixteenth century, and, therefore, in all probability, only first gave a complete account of the method of preparing it. His receipt has been followed ever since, as being the best and most certain. The English and French authors affirm that the preparation of ultramarine was discovered in England, and that a servant of the East-India Company revealed it, in order to be revenged for some injury which he had sustained : but the assertion is without foundation.

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* *Piedmontanus, de Secretis.*

ZINC.

BRASS;—TOMBACK;—PINCHBECK;—PRINCE'S METAL;—CALAMINE;—CADMIA;—DISCOVERY OF ZINC.

ZINC is a metal with which the Greeks, Romans, and Arabians were totally unacquainted, if we may judge by its not having any chemical character assigned to it in common with other metals, and by its not having been mentioned by any ancient writer. Only one instance of its having been supposed to have been discovered among some ruins of antiquity is upon record, and it was then so imperfectly examined as to leave the reality of the metal in as great obscurity as ever.

There is no doubt that the ancients were acquainted with that mixture of zinc and copper called brass; with tomback, pinch-

beck, prince's-metal, &c. Mines which contained ores from which this gold-coloured metal was derived were held in great estimation, and their exhaustion was greatly regretted. At length, however, it was discovered that a kind of earth (probably calamine, when added to copper, while in a state of fusion,) gave it a yellow colour; it was, therefore, used in the same manner as calx of cobalt was employed in colouring glass, before that metal itself was known. Both Aristotle and Strabo mention an earth of that kind, the use of which, in making brass, was retained through many centuries. But when calamine was found in sufficient quantities, the old mode of procuring brass from copper ore that contained zinc was abandoned, as it was found more convenient to extract pure copper from it first, and afterwards to convert it into brass by the addition of calamine.

The word *cadmia*, which some have supposed to signify zinc, only means ore that contained that metal; and when it was afterwards known that calamine imparted a yellow colour to copper, it also acquired that name. Brass was supposed to be only a more

valuable kind of copper. Both copper and brass were, for a great length of time, called indiscriminately *æs*, and it was not until a late period that mineralogists gave to the former the name of *cuprum*.

The first author by whom zinc is mentioned is Albertus Magnus, whom we have already had occasion to notice more than once. From the period when he wrote, which was the thirteenth century, there is no intelligible account of it until the time of Theophrastus Paracelsus, who died in 1541; and information respecting it seems to have been, even then, both scarce and imperfect.

The first person who procured this semimetal from calamine, by the addition of some inflammable substance, was one Henkel, who published an account of his discovery in 1741, but kept a portion of the process secret. The greater part of that now used is imported from the East-Indies.

END OF BOOK IV.

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